U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-252 259

Workbook for Operators of Small Boilers and Incinerators

David Sage, Inc.

Prepared For
Environmental Protection Agency

March 1976

KEEP UP TO DATE

Between the time you ordered this report—which is only one of the hundreds of thousands in the NTIS information collection available to you—and the time you are reading this message, several *new* reports relevant to your interests probably have entered the collection.

Subscribe to the **Weekly Government Abstracts** series that will bring you summaries of new reports *as soon as they are received by NTIS* from the originators of the research. The WGA's are an NTIS weekly newsletter service covering the most recent research findings in 25 areas of industrial, technological, and sociological interest—invaluable information for executives and professionals who must keep up to date.

The executive and professional information service provided by NTIS in the **Weekly Government Abstracts** newsletters will give you thorough and comprehensive coverage of government-conducted or sponsored research activities. And you'll get this important information within two weeks of the time it's released by originating agencies.

WGA newsletters are computer produced and electronically photocomposed to slash the time gap between the release of a report and its availability. You can learn about technical innovations immediately—and use them in the most meaningful and productive ways possible for your organization. Please request NTIS-PR-205/PCW for more information.

The weekly newsletter series will keep you current. But *learn what you have missed in the past* by ordering a computer **NTISearch** of all the research reports in your area of interest, dating as far back as 1964, if you wish. Please request NTIS-PR-186/PCN for more information.

WRITE: Managing Editor
5285 Port Royal Road
Springfield, VA 22161

Keep Up To Date With SRIM

SRIM (Selected Research in Microfiche) provides you with regular, automatic distribution of the complete texts of NTIS research reports *only* in the subject areas you select. SRIM covers almost all Government research reports by subject area and/or the originating Federal or local government agency. You may subscribe by any category or subcategory of our WGA **(Weekly Government Abstracts)** or **Government Reports Announcements and Index** categories, or to the reports issued by a particular agency such as the Department of Defense, Federal Energy Administration, or Environmental Protection Agency. Other options that will give you greater selectivity are available on request.

The cost of SRIM service is only 45¢ domestic (60¢ foreign) for each complete microfiched report. Your SRIM service begins as soon as your order is received and processed and you will receive biweekly shipments thereafter. If you wish, your service will be backdated to furnish you microfiche of reports issued earlier.

Because of contractual arrangements with several Special Technology Groups, not all NTIS reports are distributed in the SRIM program. You will receive a notice in your microfiche shipments identifying the exceptionally priced reports not available through SRIM.

A deposit account with NTIS is required before this service can be initiated. If you have specific questions concerning this service, please call (703) 451-1558, or write NTIS, attention SRIM Product Manager.

This information product distributed by

NTIS U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

EPA-450/9-76-001

WORKBOOK FOR OPERATORS OF SMALL BOILERS AND INCINERATORS

A SELF-INSTRUCTIONAL TEXT ON THE PROPER OPERATION AND MAINTENANCE OF SMALL OIL FIRED BOILERS AND FLUE FED INCINERATORS BASED ON NEW YORK CITY CRITERIA

EPA Contract 68-02-0321
USEPA Project Officer: W.F. Todd

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Control Programs Development Division
Air Pollution Training Institute
Research Triangle Park, NC 27711

March, 1976

231

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA - 450/9-76-001	2.	3. RECIPIENT'S ACCESSION NO. PB-252259
4. TITLE AND SUBTITLE WORKBOOK FOR OPERATORS OF SMALL BOILERS AND INCINERATORS: A self-instruction text on the Proper Operation and Maintenance of Small Oil Fired Boilers and Flue-Fed Incinerators; based on N. Y. City Criteria		5. REPORT DATE Date Issue March 1976 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) David Sage, Mariland Ruppart, C. George Segelar		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS David Sage, Incorporated 200 Park Avenue New York, New York 10017		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO. 68-02-0321
12. SPONSORING AGENCY NAME AND ADDRESS Environmental Protection Agency Office of Air and Waste Management Office of Air Quality Planning and Strategies Air Pollution Training Institute Research Triangle Park, N.C. 27711		13. TYPE OF REPORT AND PERIOD COVERED 14. SPONSORING AGENCY CODE
15. SUPPLEMENTARY NOTES		

16. ABSTRACT

A self-instructional workbook on the proper operation and maintenance of small oil fired boilers and flue-fed incinerators. The intended audience; operators in large metropolitan areas. Designed to provide fundamentals necessary to pass city certification examination. Learner is provided information, questions, and correct answers. Length of completion time is optional and is the choice of the student. Environmental Protection Agency will not certify or offer certificates of completion for the material. Use of this material is completely optional with the cities. Based on New York City criteria.

is provided

It is

the

and/is

It is

The

The

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

PRICES SUBJECT TO CHANGE

18. DISTRIBUTION STATEMENT Release Unlimited	19. SECURITY CLASS *(This Report)* Not Classified	21. NO. OF PAGES 231
	20. SECURITY CLASS *(This page)* Not Classified	22. PRICE $8.00 - 2.25

EPA Form 2220-1 (9-73)

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

US EPA

This is not an official policy and standards document.
The opinions, findings, and conclusions are those of the authors
and not necessarily those of the Environmental Protection Agency.
Every attempt has been made to represent the present state of the art
as well as subject areas still under evaluation.
Any mention of products or organizations does not constitute endorsement
by the United States Environmental Protection Agency.

To the user of this workbook .....

Unless otherwise informed, the answers you write in this book will not count toward certification. However, this book will give you information needed to pass the certification examination.

For further information about certification or additional directions about how to use this book, please read the letter which came with the book. If you are attending a training course, the instructor or person-in-charge will be able to answer all your questions.

Introduction

This is a *self-instructional* workbook. Self-instructional means *you teach yourself*. You read the information given about boilers and incinerators. This information will be followed by questions about what you have read. Always answer the questions. Always write your answers in the book. (Always use a pencil.) The correct answers to all questions are also given in the book. Always check your answers.

The answer to a question may be an explanation immediately following the question. The answer may be at the bottom of the page. However, most of the time the answer will be at the top of the next page. For example, answer the following questions. If the answer is true, place a check in the blank in front of true. If the answer is false, check false.

1) The answer to some questions will come right after the question in the book. _____True _____False.

2) The answer to some questions will be at the bottom of the page. _____True _____False.

3) The answers to most of the questions will be at the top of the next page. _____True _____False.

Now turn the page and look at the top of the page above the line.

Answers: 1) True 2) True 3) True.

This is how most questions will be answered.
Now, please continue reading below.

NEVER LOOK AT THE ANSWERS GIVEN IN THE BOOK BEFORE YOU ANSWER THE QUESTION YOURSELF. DO NOT JUST COPY THE CORRECT ANSWERS IN THE BLANKS. IF YOU DO, YOU ARE NOT LEARNING. If you cannot answer a question or if your answer was wrong, read the workbook again and then try to answer the question again. Just remembering an answer that is given in the book will not help you as much as understanding why the answer is correct.

If you do not understand the information in the workbook or if you do not understand a question, talk it over with someone - many times this will help. The city which provides this workbook will have someone in charge of answering questions. If you received the book by mail, the letter that came with it will tell you who you can contact for help. If you are in a training class, ask the instructor-in-charge.

Take your time. There is no certain time in which you must complete the workbook. The time needed will not be the same for each person. If someone completes a workbook faster than you, do not worry about it. The important thing is not how long it takes to complete the book but how much you know when you are finished.

There are many different kinds of boilers and incinerators. The workbook shows the basic things which are found on most kinds and types. The equipment in the drawings may not be exactly like your equipment. However, it will be close enough for you to follow.

Notice that some of the pages in this workbook have gray edges. These pages are the HANDBOOK Sections and appear in both the boiler and the incinerator parts of the book. You will complete the HANDBOOKS as you go along. When you have finished the workbook, you will have made a HANDBOOK for *your exact boiler or incinerator*. You can then quickly refer to your HANDBOOK pages whenever you have a problem.

A final note...
As you go through the book, you may find words that are unfamiliar. A listing of subject related words may be found on pages 59-64, Glossary.

Good Luck

Acknowledgment

The content of this self-instructional training manual was the fulfillment of Environmental Protection Agency Contract 68-02-0321. The contractor was David Sage, Incorporated, 200 Park Avenue, PanAm Building, New York, New York 10017. The developers of the materials for David Sage, Incorporated, were David Sage, Project Manager, Mariland Ruppart, Writer Analyst, and C. George Segelar, P. E., Staff Engineer. The EPA Project Officer was William C. Todd, Engineering and Enforcement Section, Air Pollution Training Institute.

The material herein was originally published by the Air Pollution Training Institute in August 1973 as SI:466, Manual for Boiler and Incinerator Operators. In the preparation of this material for publication by the Government Printing Office, the title was changed to more clearly indicate the content and identify the user. Minor technical corrections were made, based upon review by James O. Dealy, Engineering and Enforcement Section, APTI, and changes in layout and design were made, in the interest of cost, by Jack Weaver, Instructional Development Section, APTI.

The content was developed as a training aid by the Environmental Protection Agency. It is not intended to be an official policy or standards document, nor does completion of these materials imply Federal certification. A certificate is not offered by the Air Pollution Training Institute for the completion of the text. For information regarding the use of this manual, contact your city officials.

Purchase requests should be made directly to the Government Printing Office as indicated on the inside front cover. In no case should requests for manuals be directed to the Air Pollution Training Institute.

Contents

Part 1 THE PROPER OPERATION AND MAINTENANCE OF SMALL OIL FIRED BOILERS

Section 1.

THE BASICS OF PREVENTING AIR POLLUTION EMISSIONS FROM BOILERS

Topic Page

1. Choking 3
2. Smoking 4
3. Smoke Laws 5
4. Smoke Reading 6
5. Review 8
6. Ash and Smoke 9
7. Other Pollutants 10
8. Review 11
9. Air/Oil Ratio 12
10. Primary Air 13
11. Secondary Air 15
12. Draft through the Furnace 16
13. Review 17
14. Getting Oil to Burn 18
15. Boiler Parts 20

Summary 23

BOILER ROOM HANDBOOK 27

Basic Information 29
Basic Parts 31
Circulating the Oil 32
Heating the Oil 34
Steam Heater 35
Hot Water Heater 36
Electric Heater 37
Draft System 41
Controls 43
Phone Numbers 46
Basic Maintenance Supplies 47
Supplies/Reordering 49
Operation - Maintenance Summary 51
Troubleshooting Summary - General 54-56
Troubleshooting Your System 55-57
Glossary 59

Preceding page blank

Section 2.

THE BASICS OF BOILER OPERATION AND MAINTENANCE

Topic Page

1. Is Your Boiler Room in Good Shape 65
2. Daily Checks 67
3. Clean Your Smoke Alarm 70
4. Review 71
5. Getting Ready to Start 72
6. Check Out the Burner 73
7. Fifteen Minutes Later 74
8. Review 76
9. Cleaning the Cup 77
10. Clean Oil Strainer 82
11. Lubricate Weekly 85
12. Weekly Maintenance Summary 86
13. Cleaning Tubes 87
14. Automatic Soot Blower 88
15. Punching the Tubes 89
16. Review 91

Operation and Maintenance Summary 92
Summary 94

Section 3.

TROUBLESHOOTING: BOILERS - CORRECTING OIL TEMPERATURE

Topic Page

1. Smoke; What To Do When the Alarm Goes Off. 97
2. Electric Heater - Cold Oil 100
3. Electric Heater - Oil Too Hot 104
4. Cold Oil - From the Hot Water Oil Heater . 106
5. Hot Water Oil Heater - Oil Too Hot 108
6. Cold Oil From the Steam Heater 110
7. Steam Heater - Oil Too Hot 114

Summary 118

Section 4.

TROUBLESHOOTING: BOILERS - FLAME READING

Topic Page

1. Flame Away From Burner 121
2. Smoky Flame 123
3. Flame Too Long 129
4. Another Bad Flame (Too Wide) 132
5. Sparky Flame 137
6. Pulsating Flame 139
7. Review 148

Part 2 THE PROPER OPERATION AND MAINTENANCE OF FLUE FED INCINERATORS

Section 5.

INCINERATOR: BASIC PARTS AND FUNDAMENTALS

Topic Page
1. Incinerator 153
2. Incinerator Parts 154
3. Burning 156
4. After the Burn 164
5. Review 165
6. Scrubbing the Gases 166
7. Ash Catchers 172
8. Review 175
9. Multi-Chamber Incinerators 177
10. Roof Settling Chamber 178
11. Review 180
12. Double Flues 182
13. Review 186
Summary 188

Section 6.

INCINERATORS: MAINTENANCE AND TROUBLESHOOTING

Topic Page
1. Daily Cleaning 191
2. Daily Scrubber Cleaning 193
3. Review 194
4. Daily Checks 195
5. Flue Gate 196
6. Last Two Daily Checks 198
7. Scrubber - Daily Checks 200
8. Review 202
9. Periodic Maintenance 204
10. Scrubber Maintenance 208
11. Scrubber Maintenance Tasks 211
12. Troubleshooting 213
Summary 217
Review 218

INCINERATOR HANDBOOK 221
Parts - Definitions 222
Schematic 223
Reference Information 225
Maintenance - Troubleshooting 226

Part 1

THE PROPER OPERATION AND MAINTENANCE OF SMALL OIL FIRED BOILERS

Section 1
THE BASICS OF PREVENTING AIR POLLUTION EMISSIONS FROM BOILERS
including your own BOILER ROOM HANDBOOK

1. Choking

We've made a lot of progress toward cleaning up the air during the past few years, but we still have a long way to go.

PUT A CHECK BESIDE THE THINGS BELOW THAT HAVE HAPPENED TO YOU.

_____ Noticing that a thick gray cloud covers the city.

_____ Being amazed at how clear the air seems to be in the country.

_____ Finding that the metal work on the outside of your building is corroding due to pollution in the air.

_____ Taking a physical exam and wondering what pollution has done to your lungs.

Too many people are having experiences like these. Smoky boilers are part of the problem.

– Please turn the page.

Preceding page blank

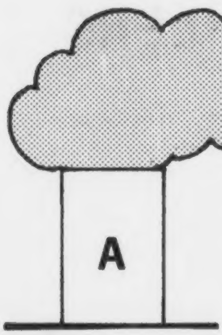
2. Smoking

We don't mind smoke, unless:

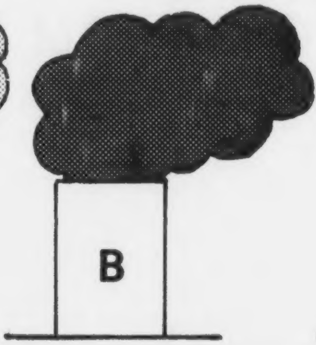
a) there is too much smoke, or

b) the smoke is too black

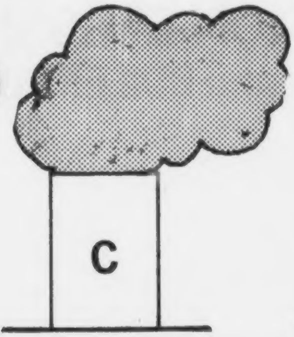
When an inspector goes out to answer a complaint about smoke, he first finds out how black the smoke is. Look at the four chimneys below. PUT "1" UNDER THE CHIMNEY THAT IS THE LIGHTEST. PUT "2" UNDER THE NEXT LIGHTEST, ETC.



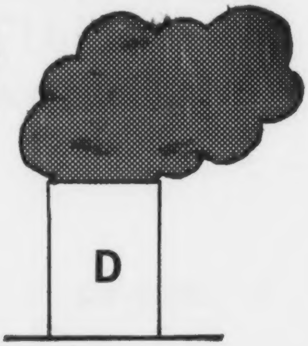
____



____



____



____

Check and correct
your answers ⇩

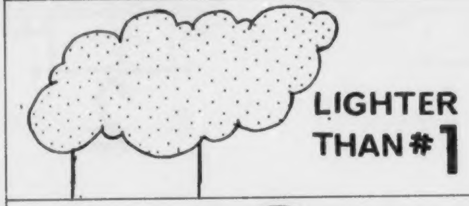
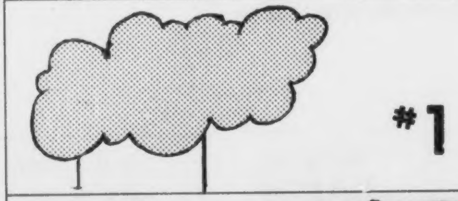
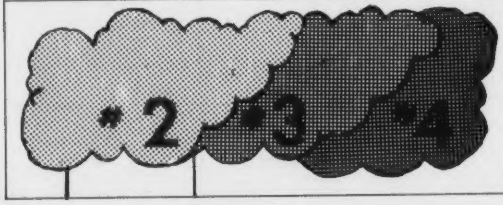
A=1, B=4, C=2, D=3

DO YOUR NUMBERS MATCH THE NUMBERS ABOVE ?

If they don't, correct your answers on this page.

3. Smoke Laws

Inspectors use the Ringelmann Chart to measure whether the smoke is dark enough to deserve a summons. The darker the smoke, the more pollutants it contains. Study this chart.

RINGELMANN SMOKE READINGS	NEW YORK CITY LAW
	ALWAYS O K
	O K if only 2 minutes an hour
	NEVER O K

Answer these questions:

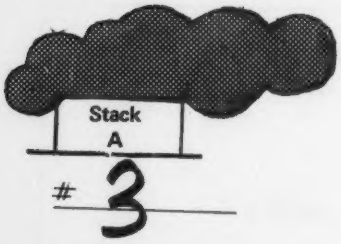
1. How long can you have # 1 smoke coming out of your stack without getting a summons? ____________________
2. Are you allowed to have # 2 smoke coming out of your stack? ____________________
3. An inspector tells if smoke is illegal by how dark it is and how long it's been coming out of the stack. (True or False) ____________________

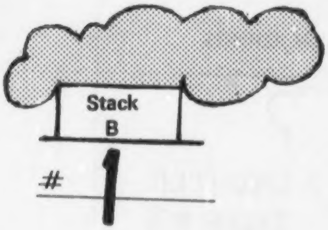
—Check your answers
on the next page.

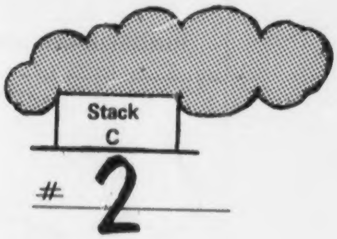
Answers to Exercise 3: 1) 2 minutes per hour 2) No
3) True

---

4. Smoke Reading







PUT THESE "READINGS" in the second column on the chart below.

STACK	RINGELMANN NUMBER (fill in from above)	MINUTES PER HOUR	VIOLATION (yes or no)
A		1 Minute	
B		3 Minutes	
C		2 Minutes	

In the last column on the chart write "YES" if the stack is a violation of the law; write "NO" if it is OK. Look back to the previous page if you need to.

After you finish the chart, answer this question:

If you were an inspector, how many summonses would you hand out from the 3 above? ________

– Check your answers
on the next page.

Answers to Exercise 4:

STACK	RINGELMANN NUMBER	MINUTES PER HOUR	VIOLATION
A	# 3	1 Minute	Yes
B	# 1	3 Minutes	Yes
C	# 2	2 Minutes	Yes

You would hand out three summonses.

5. Review

New York City is trying to clean up the air by:

- not allowing dark smoke
- allowing light gray smoke only a short time

CHECK OFF (√) THREE THINGS in the list below that are being done to cut down on pollution.

_____ Low pollution oil is being delivered to your tank.

_____ You are taking a training and certification lesson.

_____ Your oil burning boiler will be taken out.

_____ Your boiler should be upgraded to meet certain standards.

– Check your answers
on the next page.

Answers to Exercise 5:

✓ low pollution oil delivered

✓ training and certification lesson

____ oil burning boiler taken out

✓ boiler upgraded

---

6. Ash and Smoke

Many things go up your stack. ASH and SMOKE are two of the main ones you can see.

POLLUTANT	WHAT IT'S ABOUT
ASH	Minerals in the oil that will not burn. Even the best oil has a little.
SMOKE	Smoke – small, floating carbon bits are produced when oil is not burned completely. Good operation can cure this.

Answer these questions:

1. Which pollutant must we always get, no matter what we do? ____________________

2. Which pollutant is due to bad burning? ____________________

3. Which pollutant can we prevent completely? ____________________

– Check answers on the next page.

Answers to Exercise 6: 1) Ash 2) Smoke 3) Smoke

---

7. Other Pollutants

Here are four more pollutants. Study the chart. Then ANSWER THE QUESTION IN THE LAST COLUMN with "Yes" or "No". Remember that you can adjust your boiler to burn the oil completely.

POLLUTANT	WHAT IT'S ABOUT	COULD YOU STOP IT? (yes or no)
SOOT	Large pieces of carbon produced when oil is not fully burned.	
SMUT	Soot and acid mixed together. If you stop soot, you stop smut.	
CARBON MONOXIDE	Formed when oil is not burned completely.	
NITROGEN OXIDES (large amounts)	Formed when oil is burned at too high a temperature with too much air.	

You should have "Yes" in all four boxes in the last column. You can reduce or get rid of all of these pollutants if you operate your boiler correctly. ASH is the only pollutant you have to have.

CHECK THE CORRECT ANSWER BELOW:

The basic cause of the pollutants on this page is:

____ bad fuel
____ bad burning

– Check answer
on the next page.

Answer to Exercise 7: ✓ **bad burning**

---

8. Review

Check off the pollutants that you can prevent or reduce by good burning:

POLLUTANT	PREVENTABLE
Ash	
Smoke	
Soot	
Smut	
Carbon Monoxide	
Oxides of Nitrogen (large amounts)	

Check and correct your answers ⇩

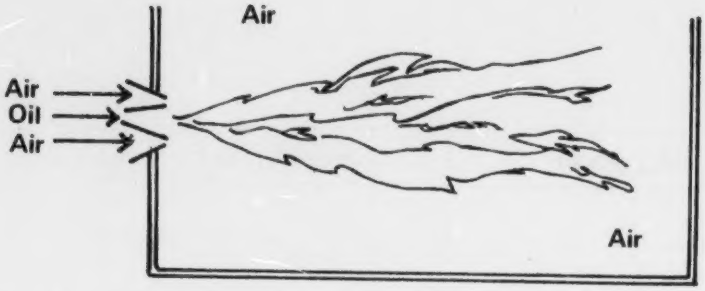
You should have a checkmark next to every one except ash. All of these preventable pollutants are due to bad burning.

Sulphur Oxides are the last pollutants. They are formed when the sulphur contained in oil is burned. We take care of this problem by using fuel having a low sulphur content to start with.

– Turn the page.

9. Air/Oil Ratio

Here is the right way to burn oil.



1. What are the two things it takes to make a flame?

   ______________ and ____________________

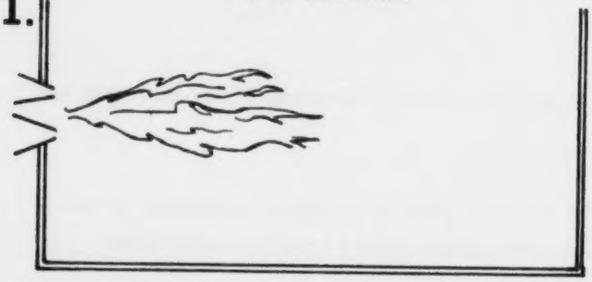
2. Does this "good flame" touch the furnace wall or floor at any point?________________

   1. AIR , OIL
   2. no

A correct mixture of air and oil will produce a good flame, which should fill the furnace without touching its walls or floor. Too much air causes the flame to become too large. UNDER EACH FLAME BELOW CIRCLE THE CORRECT ANSWER, "MUCH" or "LITTLE".

1.

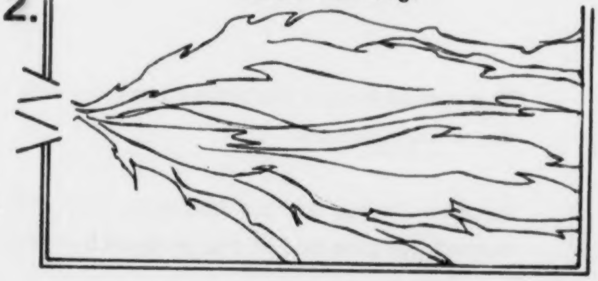
Flame Too Small



Too Much / Too Little Air

2.

Flame Too Large



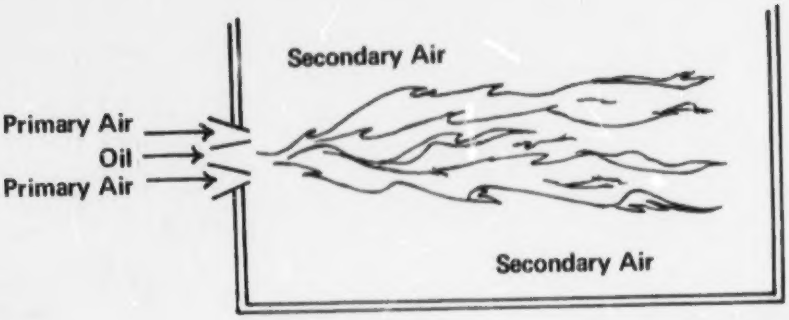
Too Much / Too Little Air

Thin flames like the one at the left result from too little air. Too much air produces a flame that is too big. Both kinds of flame produce smoke. Correct air/oil ratio is the name of the game when it comes to beating pollution.

Answers 1. Too little
2. Too much

10. Primary Air

Here's a good flame. It shows two kinds of air.


Secondary Air
Primary Air
Oil
Primary Air
Secondary Air

Complete these sentences:

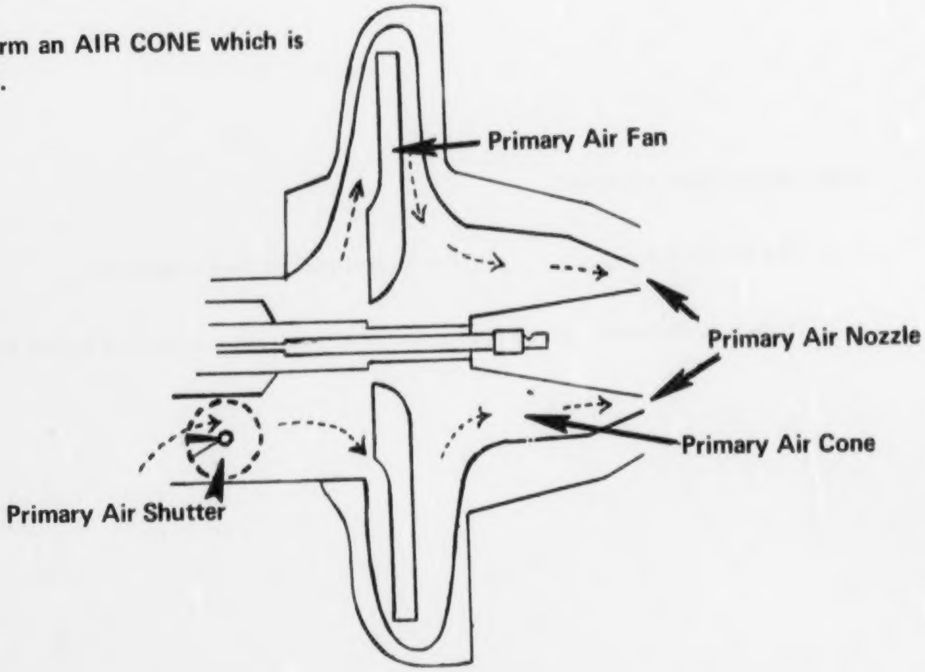
1. ________ and ________ mix together to make a flame.

2. ________ air is FIRST mixed with oil to start burning.

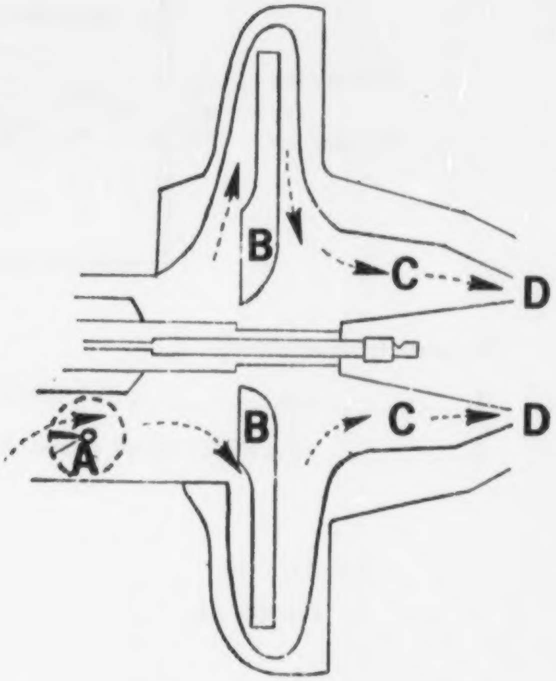
1. Air , Oil
2. Primary Air

Air comes in through the PRIMARY AIR SHUTTER and goes into the PRIMARY AIR FAN.

The fan pushes the air to form an AIR CONE which is forced out the AIR NOZZLE.


Primary Air Fan
Primary Air Nozzle
Primary Air Cone
Primary Air Shutter

Before each part WRITE THE LETTER from the diagram that shows it.



____ Primary Air Shutter

____ Primary Air Fan

____ Primary Air Cone

____ Primary Air Nozzle

Now answer these questions:

1. **The Primary Air __________ moves and pushes the primary air.**

2. **If there is the wrong amount of primary air, you get a good/bad flame. (cross out one)**

Answers to Exercise 10:

A Primary Air Shutter
B Primary Air Fan
C Primary Air Cone
D Primary Air Nozzle

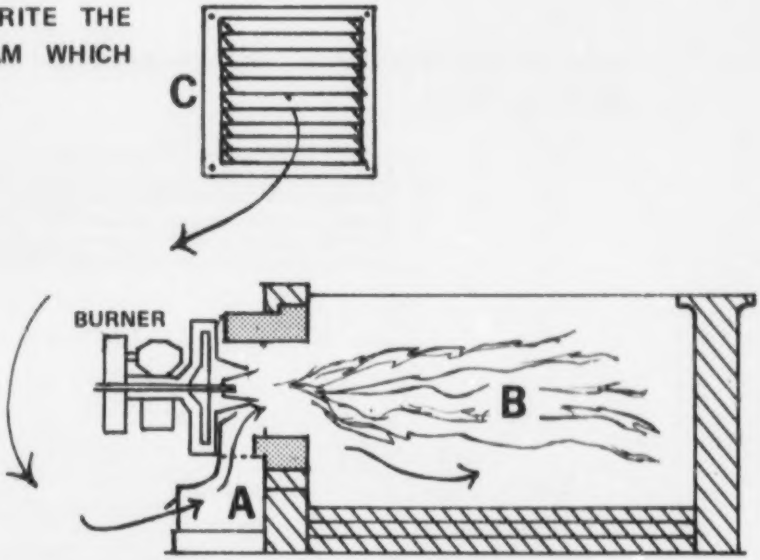
1) Fan
2) Bad Flame

---

11. Secondary Air

A lot of Secondary Air is needed around the flame. More Secondary Air is needed than Primary Air.
Fresh air comes in from outside through a LOUVER in the wall.
Air goes through the WINDBOX into the firebox.
The FIREBOX is where the flame is.

BESIDE EACH PART below WRITE THE LETTER FROM THE DIAGRAM WHICH SHOWS IT:



____ OUTSIDE LOUVER

____ WINDBOX

____ FIREBOX

Answer these questions:

1. Name the two kinds of air a good flame needs:
   ________________, ____________________
2. Do you need more Secondary or Primary Air? ____________________
3. When there isn't enough Secondary Air, what kind of flame will you get?
   ____
4. If the outside louver is covered up, enough ________________ can't get in.

—Check your answers.

Answers to Exercise 11:

C Outside Louver
A Windbox
B Firebox

1) Primary, Secondary
2) Secondary
3) Bad Flame
4) air

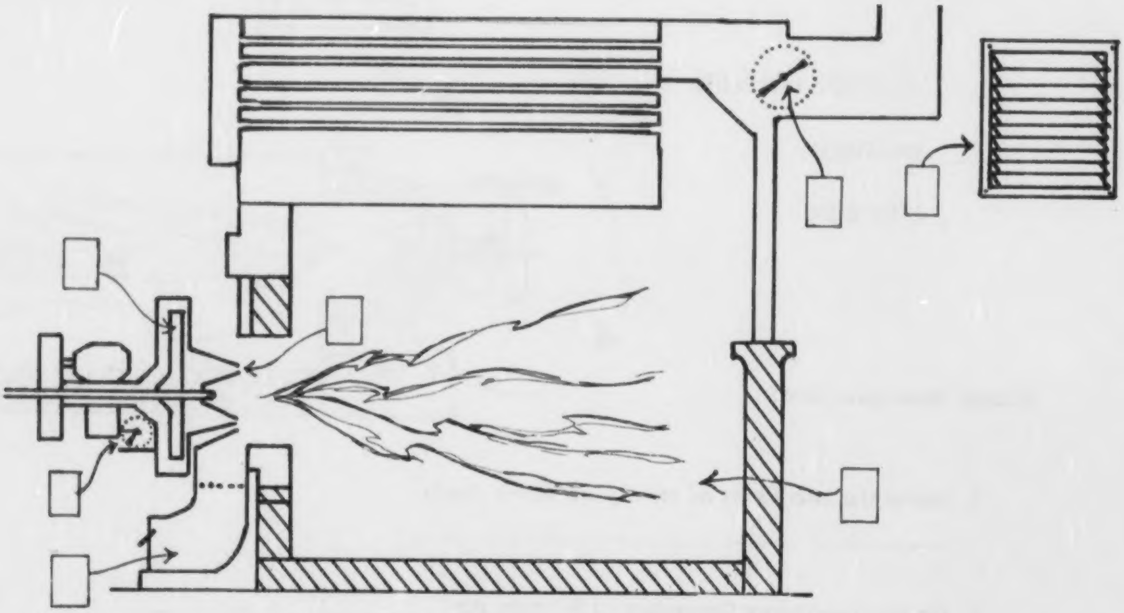
---

12. Draft Through The Furnace

There must be draft to pull air into the firebox, to help air mix with the flame, and draw hot gases up the stack. Draft is very important for a good flame.

A damper in the chimney uptake controls draft. In small plants, this damper is operated by hand. In plants burning 25 gallons per hour or more it is automatic.

Label the parts of the primary air, secondary air and draft systems on the diagram with the correct letter from the list.



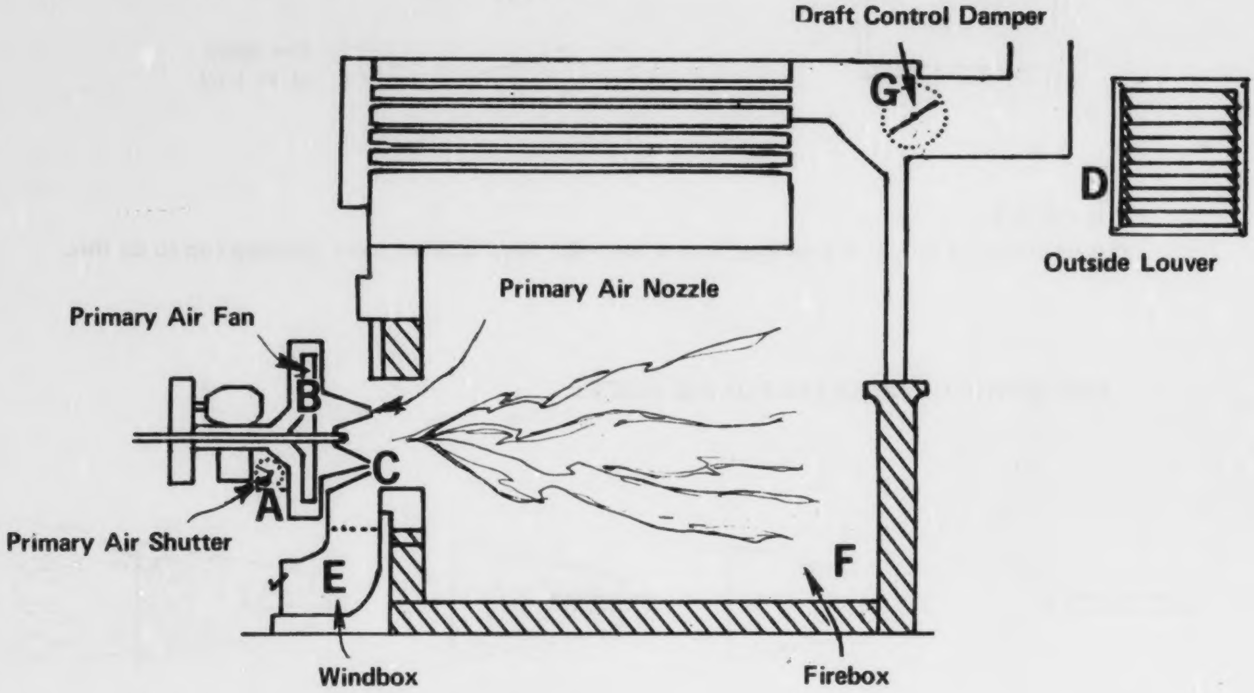
A. Primary Air Shutter
B. Primary Air Fan
C. Primary Air Nozzle
D. Outside Louver
E. Windbox
F. Firebox
G. Draft Control Damper

– Check answers on the next page.

13. Review

The right air/oil ratio is needed for good burning. Check your diagram on the opposite page with this one.

ANSWERS TO PREVIOUS PAGE:


Draft Control Damper
G
D
Outside Louver
Primary Air Nozzle
Primary Air Fan
B
C
A
Primary Air Shutter
E
F
Windbox
Firebox

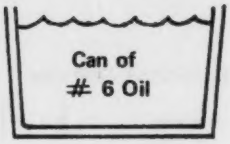
When all of these parts are working right, the flame will get the air it needs.

Turn the page.

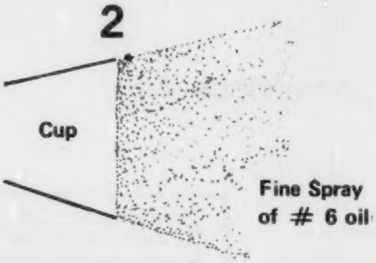
14. Getting Oil To Burn

CIRCLE THE PICTURE SHOWING WHAT OIL IS LIKE WHEN IT IS BURNED.

1.



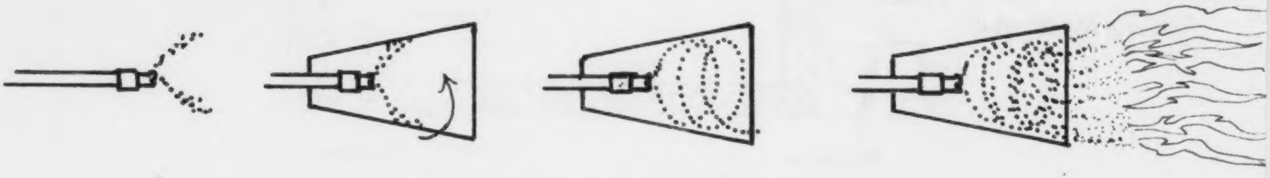
2



2 is correct . . .

# 6 oil will burn only if it is sprayed into a fine mist. Most burners use a spinning cup to do this.

THIS IS WHAT HAPPENS IN YOUR BURNER:



1

Nozzle feeds oil into cup.

2

Spinning cup picks up oil stream.

3

When cup is smooth - oil spins into a fine mist.

4

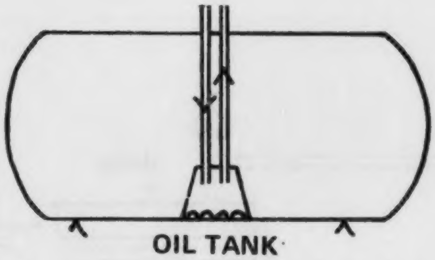
Oil drops are sprayed into the air coming from primary air around the cup - mixed with air and burned.

Only tiny oil drops will burn completely. When the cup is damaged, the oil drops become larger.

What happens to an oversized oil blob in the firebox? ______________________________

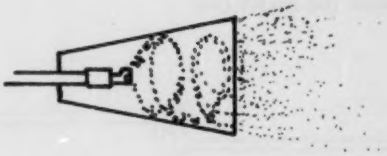
If you said "big blobs don't burn completely" or something like that, you're right.

CIRCLE COLD or HOT and THICK or THIN under each picture, which ever is right.



OIL TANK

1 OIL OUTSIDE THE COIL IS
COLD/HOT and THICK/THIN



OIL CUP

2. OIL IS
COLD/HOT and THICK/THIN

Answers

1. The oil starts out COLD and THICK and
2. ends up HOT and THIN.

NUMBER THIS LIST IN THE RIGHT ORDER:

____ Truck delivers oil to fuel tank.

____ Oil is heated to proper temperature.

____ Oil is pumped into the cup and spun for burning.

____ Oil is pumped from tank to heaters.

Check and correct
your answers ⇩

Answers

1 Truck delivers oil to fuel tank.

3 Oil is heated to proper temperature.

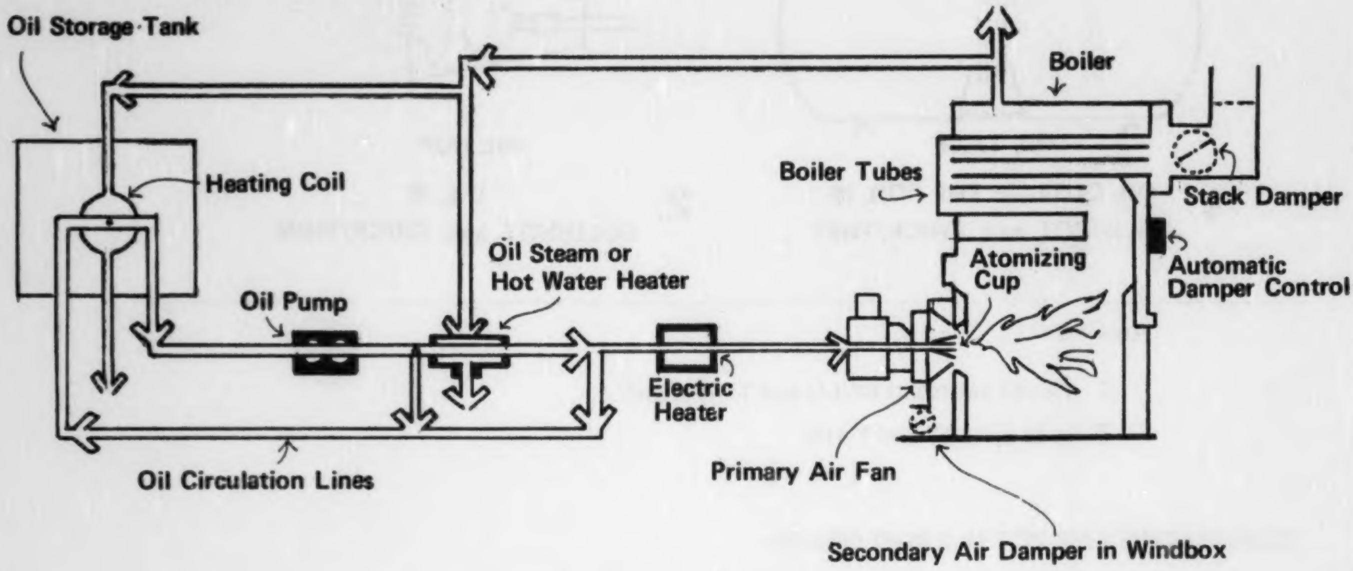
4 Oil is pumped into the cup and spun for burning.

2 Oil is pumped from tank to heaters.

15. Boiler Parts

A boiler system contains the parts shown below. Larger systems will have more parts; smaller systems may have fewer parts. In this diagram all of the parts are stretched out to show them clearly. Your equipment may be wrapped around the boiler.

Study this and answer the questions


Oil Storage Tank
Heating Coil
Oil Pump
Oil Steam or Hot Water Heater
Electric Heater
Oil Circulation Lines
Boiler
Boiler Tubes
Stack Damper
Atomizing Cup
Automatic Damper Control
Primary Air Fan
Secondary Air Damper in Windbox

1. What heats the oil in the tank? ____________________

2. After the tank, how many oil heaters are there in this system? ____________________

3. What piece of equipment moves the oil through the fuel lines? ____________________

4. The oil is sprayed into the firebox by the: ____________________

5. Secondary air enters the firebox through the: ____________________

6. What piece of equipment gets the primary air moving into the firebox? ____________________

— Check your answers at top of next page.

Answers to Exercise 15:		
	1) Heating Coil	4) Atomizer Cup
	2) Two	5) Air Damper in Windbox
	3) Oil Pump	6) Primary Air Fan

PUT A CHECK IN THE CORRECT COLUMN NEXT TO EACH BOILER PART. The first one is done for you. Pipes are used in moving the oil.

BOILER PARTS	HAS TO DO WITH			
	AIR	HEATING	STORAGE & MOVING	BURNING
1. Pipes			✓	
2. Electric Heater				
3. Cup (Atomizing)				
4. Secondary Air (Windbox)				
5. Primary Air Fan				
6. Fuel Storage Tank				
7. Steam or Hot Water Oil Heater				
8. Automatic Damper Control				
9. Stack Damper				
10. Fuel Tank Heating Coil				

– Check your answers on the next page.

Answers to previous page

BOILER PARTS	HAS TO DO WITH			
	AIR	HEATING	STORAGE & MOVING	BURNING
1. Pipes			✓	
2. Electric Heater		✓		
3. Cup (Atomizing)				✓
4. Secondary Air (Windbox)	✓			
5. Primary Air Fan	✓			
6. Fuel Storage Tank			✓	
7. Steam or Hot Water oil Heater		✓		
8. Automatic Damper Control	✓			
9. Stack Damper	✓			
10. Fuel Tank Heating Coil		✓		

Summary

These questions review the important things in this section:

1. A Ringelmann Chart measures how ____________ the smoke is.

2. Ringelman 1 smoke is allowed if the length of ________ is less than two minutes.

3. What happens if you have too much dark smoke?

____

4. Check the pollutants you can reduce or prevent:

___ Ash
___ Smoke
___ Soot
___ Smut
___ Carbon Monoxide
___ Nitrogen Oxides

5. When air and oil are not properly mixed, the result is __________ which results in smoke.

6. What term (including the ingredients of burning) is the key to good burning? ______ ratio

7. Name the two "types of air" used in the burning of fuel:

____

____

8. What equipment delivers the two "types of air"?

____

____

9. What draws the air through the furnance?

____

10. How does air first get into the boiler room?

____

11. What do you get if you have the wrong amount of air or if the oil is not atomized correctly?

____

12. What form must oil be in, in order to burn? ______________________________

13. What must be done to the oil before it can be atomized?

____

14. Circle the correct words:

    a) All boilers are the same/different.
    b) The atomizing cup is the center of the burner/heater.
    c) Boilers ususally have electric and steam generators/heaters.

Answers to Summary

1. black or dark
2. time
3. summons
4. ____ Ash __✓__ Smoke __✓__ Soot __✓__ Smut __✓__ Carbon Monoxide __✓__ Nitrogen Oxides
5. bad burning
6. air/oil
7. primary, secondary
8. primary air shutter or fan, windbox
9. draft or damper in the chimney
10. air louvers on outside wall
11. bad burning or poor flame
12. fine, even mist
13. heated
14. a) different
    b) burner
    c) heaters

GRAY-EDGED pages are special!

Take this BOOK to your boiler room.

Get a pencil and a piece of chalk. As you follow the instructions given on each page, you will be putting together a manual for running your boiler. It will contain lists of:

- correct instrument readings and control settings
- spare parts you should keep on hand
- names and model numbers of parts of your boiler system to use when ordering parts or calling service
- fuel oil suppliers, service contractors and others whom you may need from time-to-time

These lists will be different for each boiler room. That's why only you can fill out your own manual in your own boiler room. As you do it, make allowances for the fact that no two boiler rooms are alike. Yours may be very different from the diagrams shown here. That's OK. The important thing is to make sure you know where everything is and to get the information you need to do your job right.

Remember...

Gray-Edged pages are a Handbook for YOUR BOILER!

BOILER ROOM HANDBOOK

OPERATING AND MAINTENANCE MANUAL
FOR THE BOILER AND BOILER ROOM

AT

Building

Street

Borough Zip

Prepared By

Boiler Operator

Date

Preceding page blank

CONTENTS

Basic Information ______ 29
Basic Parts ______ 31
Circulating the Oil ______ 32
Heating the Oil ______ 34
Steam Heater ______ 35
Hot Water Heater ______ 36
Electric Heater ______ 37
Draft System ______ 41
Controls ______ 43
Phone Numbers ______ 46
Basic Maintenance Supplies ______ 47
Supplies/Reordering ______ 49
Operation - Maintenance Summary ______ 51
Troubleshooting Summary - General ______ 54 - 56
Troubleshooting Your System ______ 55 - 57
Glossary ______ 59

BASIC INFORMATION

The two things in the box are required by law to be posted in your boiler room.

1. Burner Manufacturers' Instruction Card
2. City Upgrading Certificate

Look around your boiler room and answer the questions below:

1. List the Manufacturers' Instruction Cards which are posted in your boiler room:

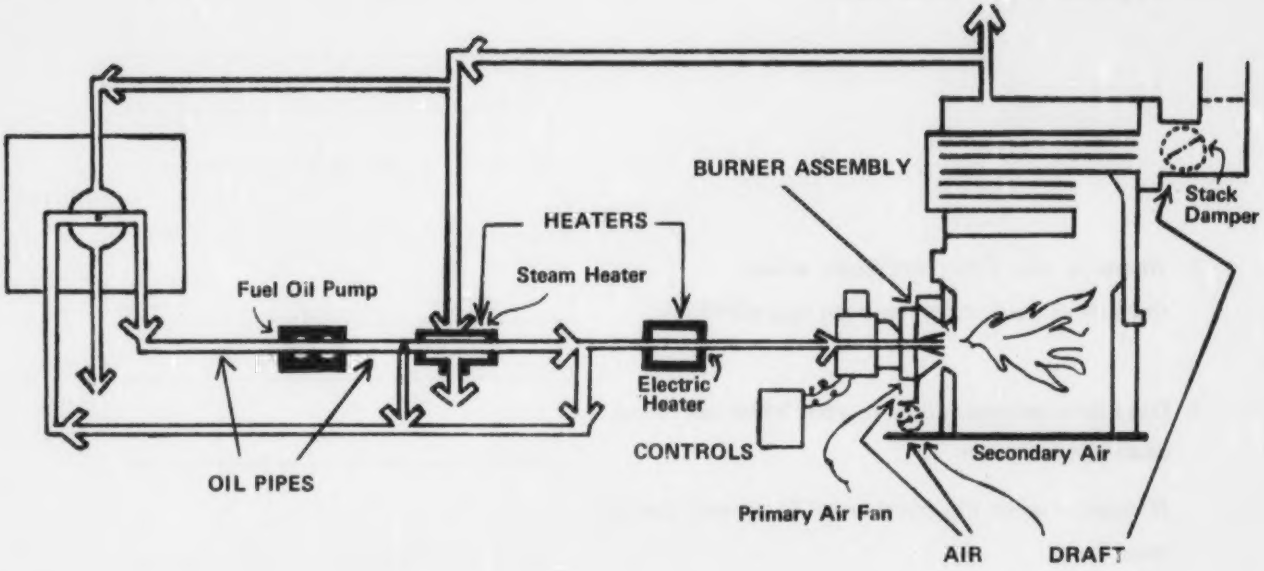
2. Where is the City Certificate which shows that your boiler has been upgraded?

3. Does the electrical source to your boiler have fuses or circuit breakers?

   If fuses – write the number of fuses and size in amps here.

4. Where is your remote control switch?

Go on to the next page.


BURNER ASSEMBLY
Stack Damper
HEATERS
Steam Heater
Fuel Oil Pump
Electric Heater
CONTROLS
Secondary Air
OIL PIPES
Primary Air Fan
AIR
DRAFT

SOME BASIC PARTS

Five major parts of a typical system are shown on this diagram. Using it for reference, take the chalk and mark the following numbers on your boiler system (if you cannot find any part, skip it and go on to the next one):

FIRST find the OIL PIPES:

Write a 1 anywhere on the oil supply pipe leading from the fuel tank to the heaters.

Write a 2 anywhere on the pipe leading from the electric heater to the burner.

NEXT find your OIL HEATERS:

Write a 3 on your Steam Heater or Hot Water Oil Heater

Write a 4 on your Electric Heater

NEXT you will mark the AIR delivering parts:

Write a 5 on your Primary Air Fan Casing.

Write a 6 on the Windbox (Secondary Air).

Write a 7 on the breeching as close to the stack damper as you can reach.

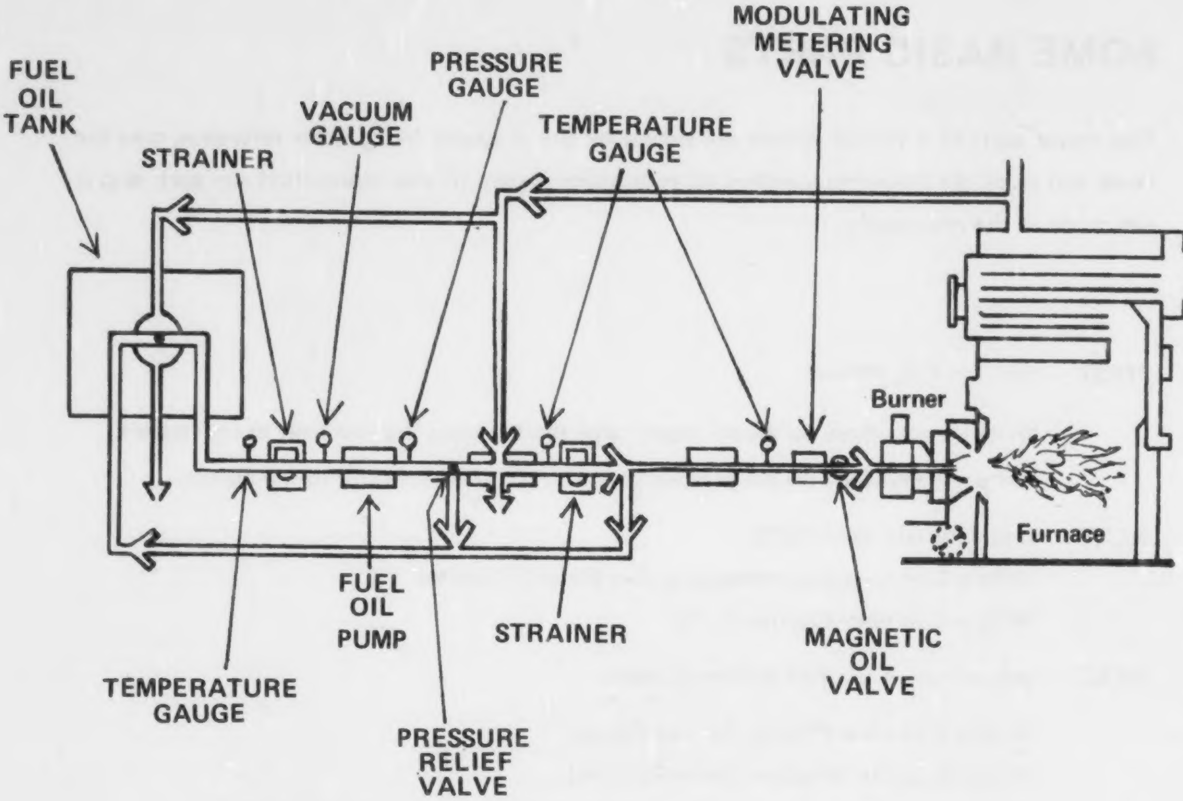
NEXT find your CONTROL BOARD:

Write an 8 on your Control Board.

LAST go to your BURNER ASSEMBLY:

Write a 9 on the front plate of the burner.

Go on to the next page.


FUEL OIL TANK
STRAINER
VACUUM GAUGE
PRESSURE GAUGE
TEMPERATURE GAUGE
MODULATING METERING VALVE
Burner
Furnace
TEMPERATURE GAUGE
FUEL OIL PUMP
PRESSURE RELIEF VALVE
STRAINER
MAGNETIC OIL VALVE

CIRCULATING THE OIL

To complete this page, find parts on your boiler system that have to do with MOVING THE OIL. Above is a general diagram.

Find each of the parts below on the diagram, then locate it in your boiler room. Put a check in the box before each part when you find it. Then, answer the questions about it.

☐ **FUEL OIL TANK**

1. **How many gallons does your tank hold?** ____________________
2. **What is a five-day supply for you in winter?** ____________________

☐ **FUEL OIL PUMP**

1. **What is the make and model number of your pump?**
2. **What is the belt size for it?** ____________________

____

☐ **TEMPERATURE GAUGES ON OIL LINES**

Complete this chart for the number of temperature gauges that you have:

NO OF. GAUGES	LOCATION	CAN REPLACE? (yes/no)	MAKE
1			
2			
3			
4			
5			

☐ **VACUUM GAUGE**

☐ **PRESSURE**

Complete this chart for these gauges:

	NORMAL RANGE	REPLACEMENT SPECS.
VACUUM GAUGE		
PRESSURE GAUGE		

☐ **OIL STRAINERS**

1. How many strainers do you have? ____________
2. Are they single or double basket? ____________
3. Do you know the make and model number? ____________

☐ **PRESSURE RELIEF VALVE**

☐ **MODULATING METERING VALVE**

☐ **MAGNETIC OIL VALVE**

Complete this chart for these valves:

	LOCATED? (yes/no)	DO YOU ADJUST THIS? (yes/no)
PRESSURE RELIEF VALVE		
MODULATING METERING VALVE		
MAGNETIC OIL VALVE		

Go on to the next page.

HEATING THE OIL

These pages will help you locate boiler parts which HEAT your oil.

FIRST – CHECK OFF THE OIL HEATERS BELOW WHICH YOU HAVE ON YOUR SYSTEM:

___ 1. Steam Heater
___ 2. Hot Water Oil Heater
___ 3. Electric Heater

COMPLETE ONLY THE PAGES FOR THE HEATERS YOU HAVE.

If you have a Steam Heater, complete page 35
If you have a Hot Water Oil Heater, complete page 36
If you have an Electric Heater, complete page 37

Remember, you will have to do this in your own boiler room.

CIRCLE THE PAGES BELOW WHICH YOU WILL COMPLETE.

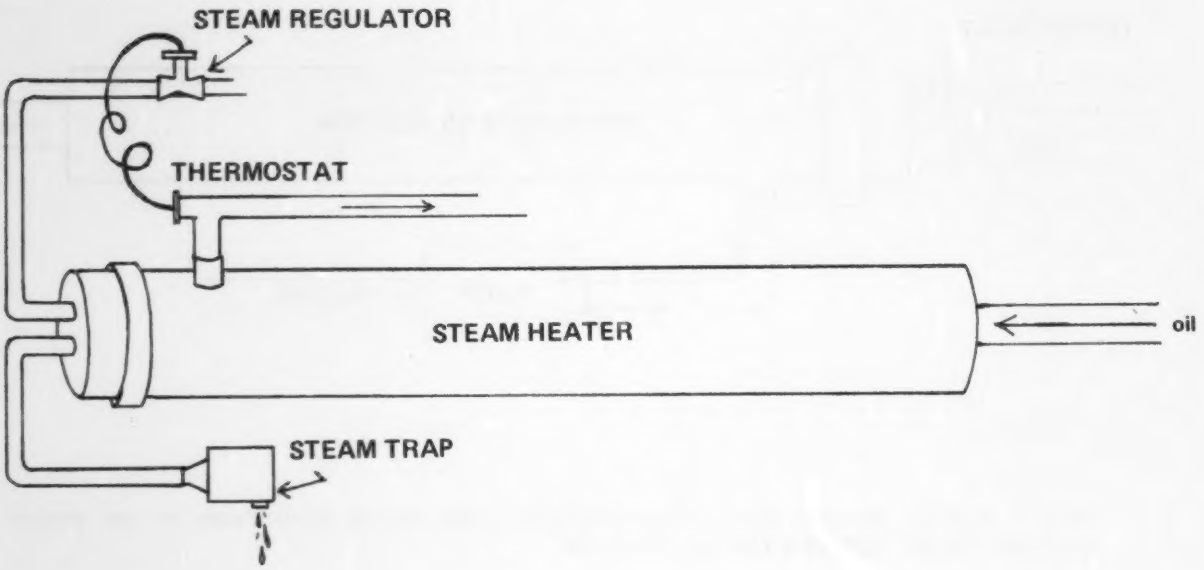
35 36 37

COMPLETE THE PAGES YOU HAVE CIRCLED. When you have finished, go on to page 38

REMEMBER: Heater thermostat settings depend on what kind of oil you are burning.

STEAM HEATER

Complete this page only if you have a Steam Heater. Use this general diagram to do the work below.



PUT A CHECK IN THE BOX BEFORE EACH ITEM WHEN YOU FIND IT ON YOUR SYSTEM. THEN, ANSWER THE QUESTIONS.

☐ STEAM HEATER

1. What is the make and model number of your heater? ____________________

☐ THERMOSTAT

1. At what temperature should your steam heater thermostat be set? ____________________

☐ STEAM REGULATOR

1. Is the set screw on your steam regulator tight? ____________________

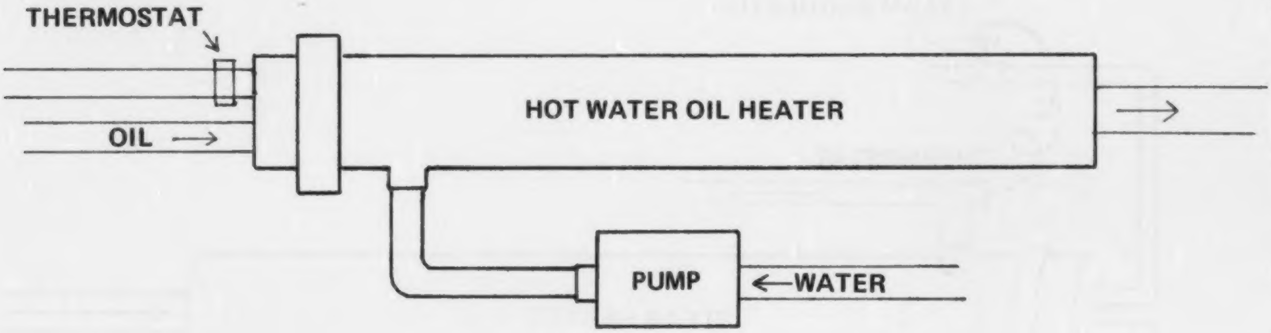
☐ STEAM TRAP

1. Is there any water (condensation) coming out of your steam trap now? ____________________

If you have a Hot Water or Electric Oil Heater, go on to those pages.

HOT WATER OIL HEATER

Complete this page only if you have a Hot Water Oil Heater. Use this general diagram for reference.



PUT A CHECK IN THE BOX BEFORE EACH ITEM AFTER YOU FIND IT ON YOUR SYSTEM. THEN, ANSWER THE QUESTIONS.

☐ **HOT WATER OIL HEATER**

1. What is the make and model number of your heater? ____________________

☐ **THERMOSTAT**

1. At what temperature should your Hot Water Oil Heater Thermostat be set? ____________________

☐ **PUMP SERVING THIS HEATER**

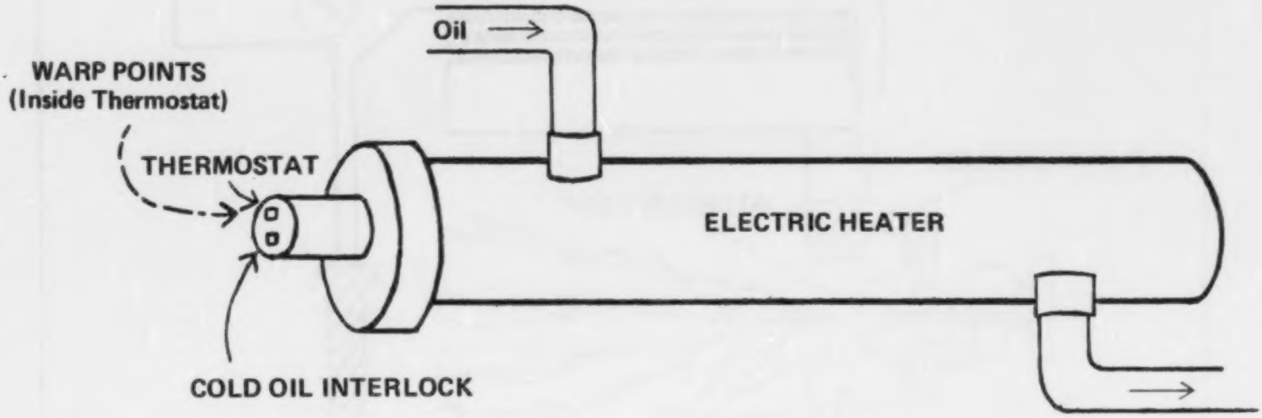
1. Is there a separate pump for this heater? ____________________
2. If so, what is the make and model number? ____________________
3. If so, list the size of any belt on it. ____________________
4. What is the size of the motor (HP) for this pump? ____________________

CIRCLE any part or question above that you cannot find or answer. Ask your instructor about these at the next class session.

If you have an Electric Heater, go on to the next page.

ELECTRIC HEATER

Complete this page only if you have an Electric Heater. Use this general diagram as reference.


Oil
WARP POINTS (Inside Thermostat)
THERMOSTAT
ELECTRIC HEATER
COLD OIL INTERLOCK

PUT A CHECK IN THE BOX BEFORE EACH ITEM AFTER YOU HAVE FOUND IT ON YOUR SYSTEM. THEN, ANSWER THE QUESTIONS.

☐ **ELECTRIC HEATER**

Complete this chart for your Electric Heater:

	MAKE	MODEL NUMBER	WATTAGE
ELECTRIC HEATER			

☐ **THERMOSTAT**

1. At what temperature should your electric heater thermostat be set? (atomizing temperature) ____________________

☐ **COLD OIL INTERLOCK**

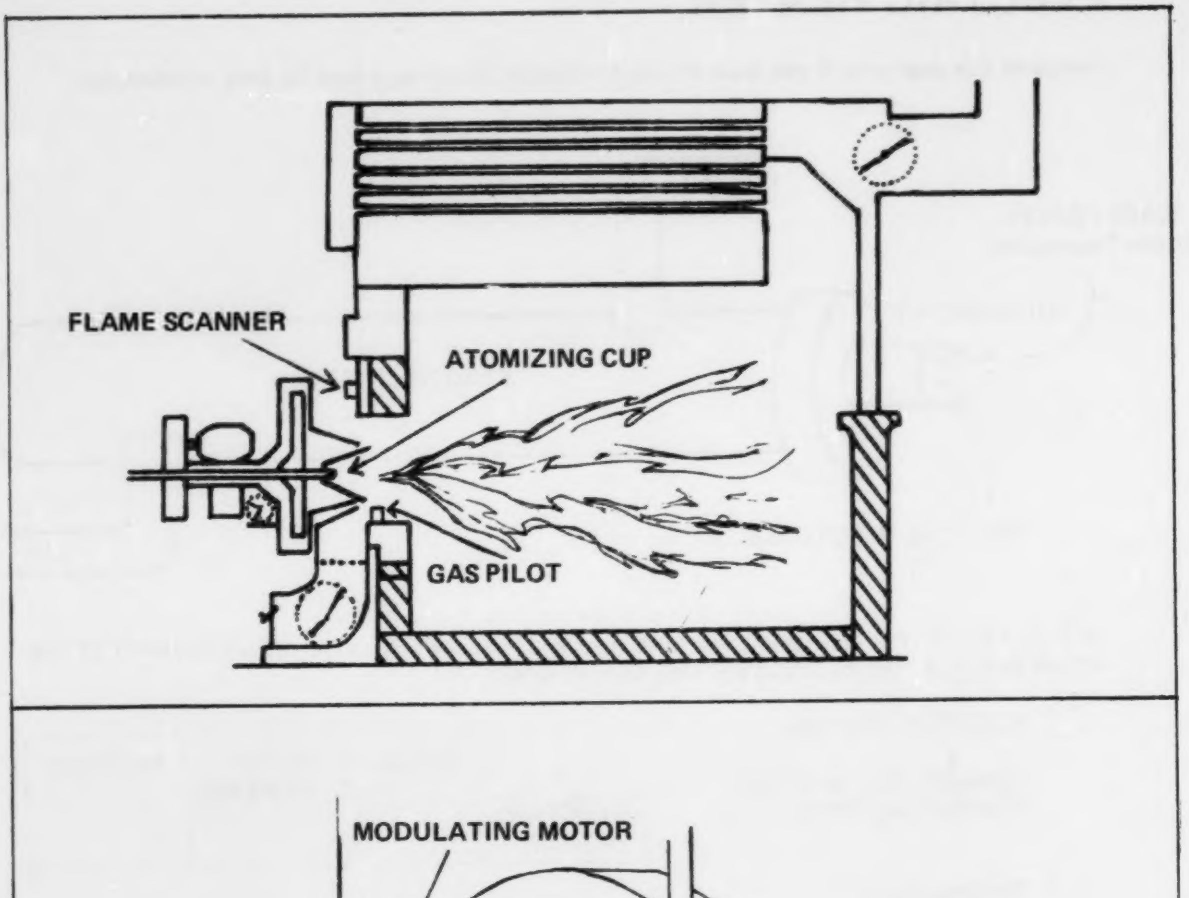
1. At what temperature should your cold oil interlock be set? (15° below thermostat setting) ____________________

☐ **WARP POINTS (inside thermostat)**

1. If you change these, what are the specs? ____________________

Go on to the next page.

BURNER ASSEMBLY


FLAME SCANNER
ATOMIZING CUP
GAS PILOT
MODULATING MOTOR
BURNER HINGE/LATCH
SOLID LINKAGE

BURNER ASSEMBLY

On this page you will locate the basic parts of your burner assembly. Refer to the diagrams on the opposite page.

PUT A CHECK IN THE BOX BEFORE EACH PART WHEN YOU FIND IT ON YOUR SYSTEM. THEN, ANSWER THE QUESTIONS.

☐ GAS PILOT

1. What is your pilot electrode size? ______________________

☐ BURNER

1. Look on your burner main-plate to find the make and model number. ______________________
2. What is your burner motor size (HP) ? ______________________
3. What are the belt sizes? ______________________
4. Do you have a lube oil indicator or must you look in the reservoir? ______________________

☐ MODULATING MOTOR

1. What is the make and model number? ______________________

☐ ATOMIZING CUP

1. What is the make and size? (If not given, measure cup opening and side length.) ______________________

☐ SOLID LINKAGE

1. Are settings permanently marked on the burner plate or do you mark them? ______________________

☐ FLAME SCANNER

1. What type do you have: A. Lead Sulphide
   B. Ultra-Violet Ray
   C. Flame Rod
   D. Photo-Cell ______________________
2. What is the make and model number? ______________________

☐ BURNER HINGE/LATCH

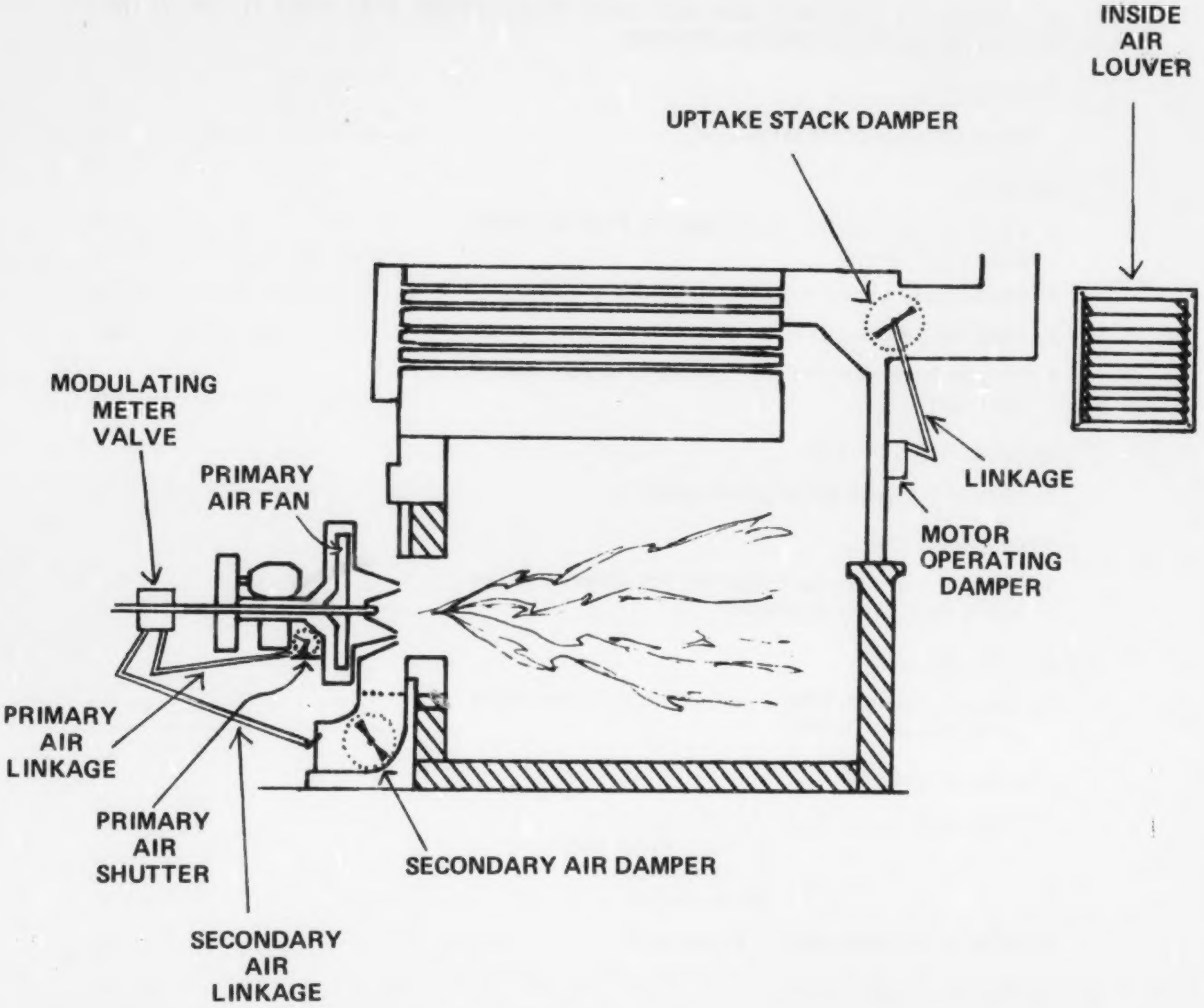
1. How many twist plugs or "dogs" must be disconnected to open your boiler? ______________________

☐ COVER FOR BURNER OPENING

1. Where is this kept when your burner is operating? ______________________

Go on to the next page.

DRAFT SYSTEM


INSIDE AIR LOUVER
UPTAKE STACK DAMPER
MODULATING METER VALVE
PRIMARY AIR FAN
LINKAGE
MOTOR OPERATING DAMPER
PRIMARY AIR LINKAGE
PRIMARY AIR SHUTTER
SECONDARY AIR DAMPER
SECONDARY AIR LINKAGE

DRAFT SYSTEM

Here you will locate parts of your system which provide air to the burner. Use the diagrams on the opposite page.

PUT A CHECK IN THE BOX BEFORE EACH PART WHEN YOU LOCATE IT ON YOUR SYSTEM. THEN, ANSWER THE QUESTIONS.

☐ FRESH AIR INTAKE INTO BOILER ROOM

1. How many windows or fixed louvers does your boiler room have? ____________________

☐ PRIMARY AIR SHUTTER, FAN, LINKAGE

1. Is the opening to the shutter clear? ____________________
2. What is the fan belt size? ____________________
3. Does the fan seem to be in good working order? ____________________

☐ SECONDARY AIR DAMPER, LINKAGE

1. Does the damper move freely? ____________________
2. Does the linkage move freely? ____________________
3. Is the linkage in the right position? ____________________

☐ UPTAKE DAMPER IN STACK, LINKAGE

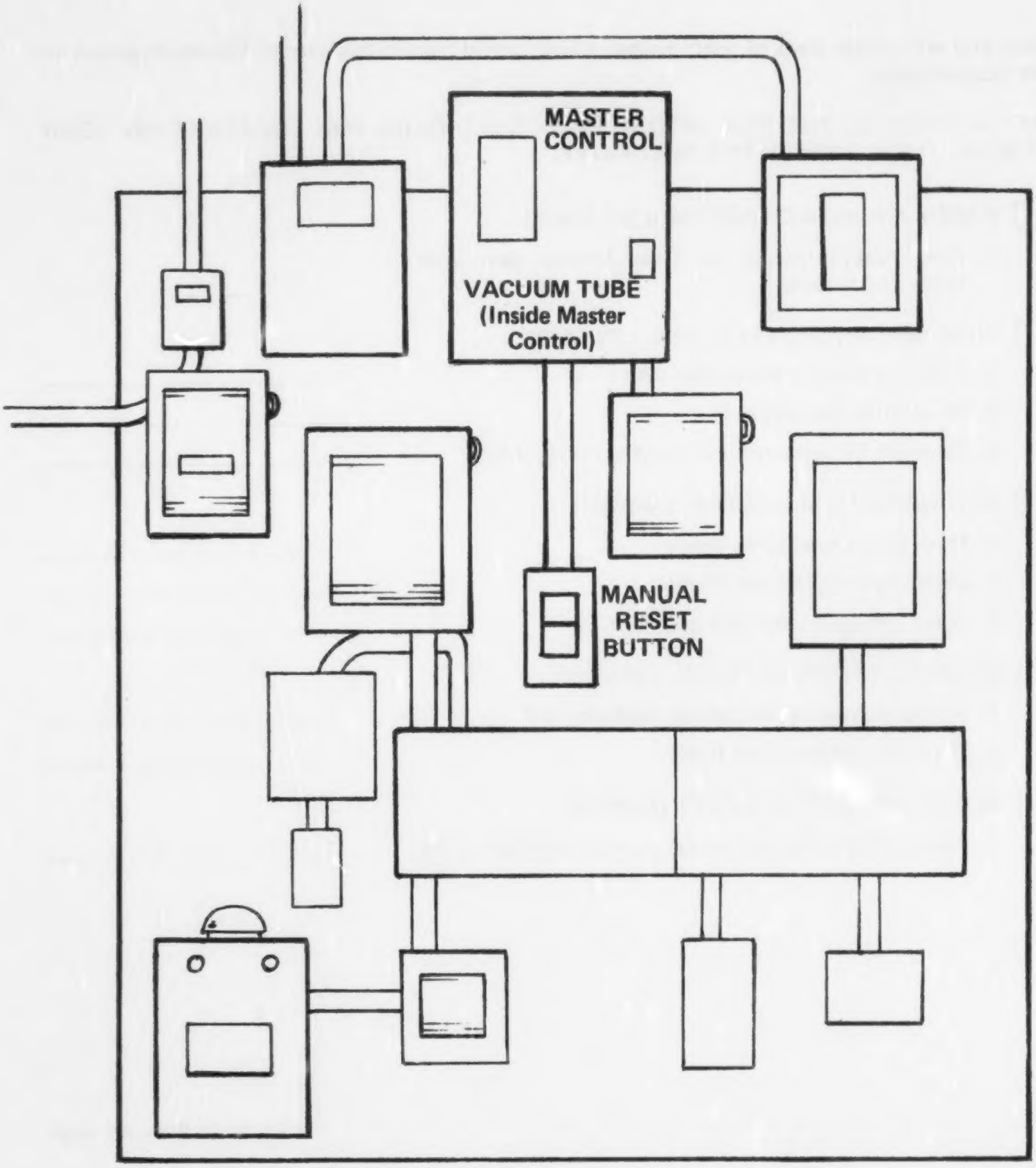
1. Is your damper automatic or manually set? ____________________
2. Does this linkage move freely? ____________________

☐ MOTOR OPERATING DRAFT DAMPER

1. What is the make and model number of this motor? ____________________

Go on to the next page.

CONTROLS


MASTER CONTROL
VACUUM TUBE (Inside Master Control)
MANUAL RESET BUTTON

CONTROLS

This page and the next are concerned with basic boiler controls. This page (with the opposite diagram) includes controls that usually appear on the Control Board.

PUT A CHECK IN THE BOX BEFORE EACH PART WHEN YOU LOCATE IT ON YOUR SYSTEM. THEN, ANSWER THE QUESTIONS.

☐ CONTROL BOARD

Where is your Control Board? ______________________

☐ MASTER CONTROL SWITCH

Where is your Master Control Switch located? ______________________

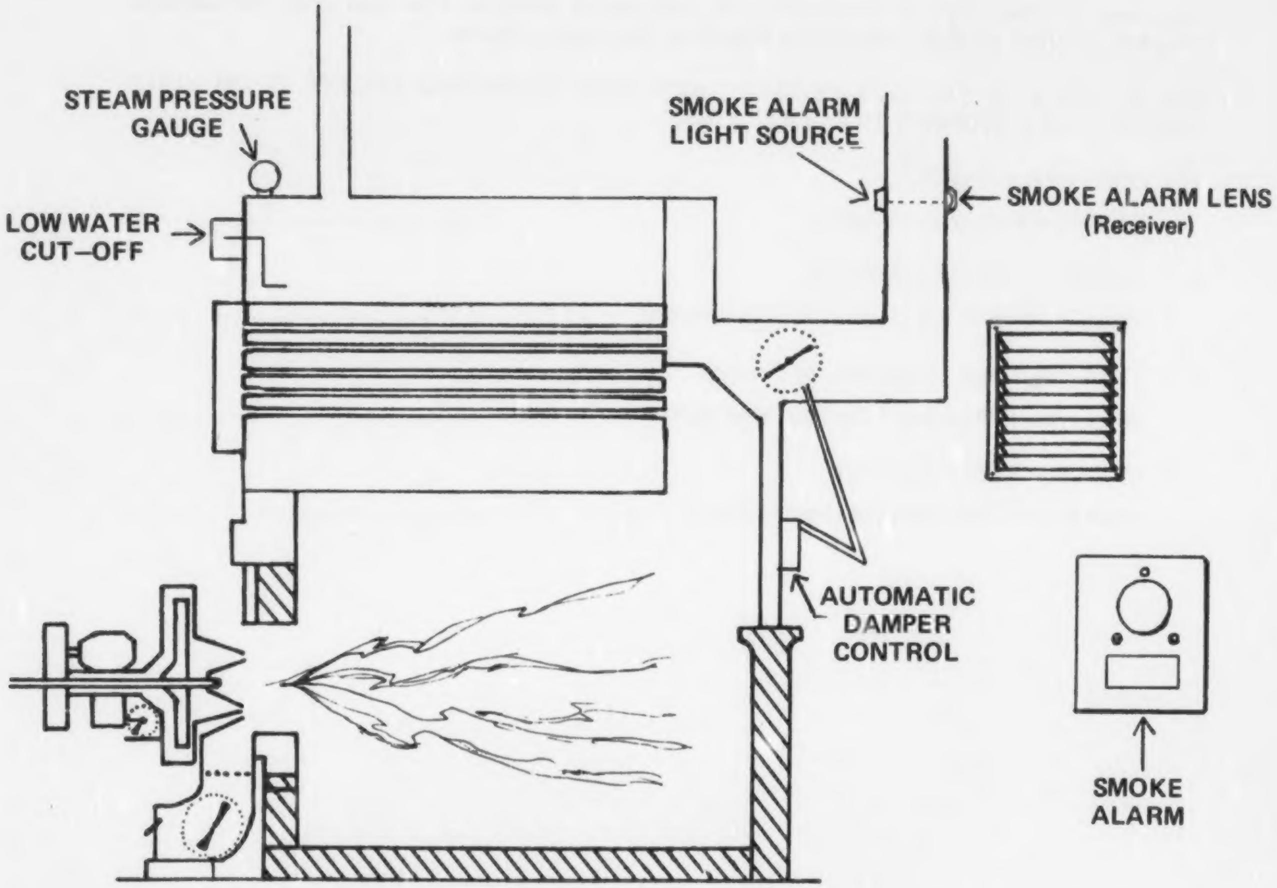
☐ VACUUM TUBE (inside Master Control)

What type of Vacuum Tube does your system use? ______________________

☐ MANUAL RESET BUTTON

What color is your Manual Reset Button? ______________________

Go on to the next page.


STEAM PRESSURE GAUGE
LOW WATER CUT–OFF
SMOKE ALARM LIGHT SOURCE
SMOKE ALARM LENS (Receiver)
AUTOMATIC DAMPER CONTROL
SMOKE ALARM

CONTROLS (continued)

These controls will be located on and around your boiler.

PUT A CHECK IN THE BOX BEFORE EACH PART AS YOU FIND IT ON YOUR SYSTEM. THEN, ANSWER THE QUESTIONS.

☐ **LOW WATER CUT–OFF**

How often do you clean your low water cut-off? ____________________

☐ **STEAM PRESSURE GAUGE ON BOILER**

If you have one, what is the correct pressure reading on your boiler? ____________________

☐ **AUTOMATIC DAMPER CONTROL** (on boilers of 25 gallons per hour or more)

Do you have an automatic damper control? ____________________

☐ **SMOKE ALARM**

What kind of smoke alarm do you have (light, bell, etc.)? ____________________

☐ **SMOKE ALARM SENSOR** (light source)

Where is your smoke alarm light source located? ____________________

☐ **SMOKE ALARM SENSOR** (receiver, lens)

Can your smoke alarm lens be reached for cleaning? ____________________

Go on to the next page.

IMPORTANT TELEPHONE NUMBERS

Complete this list of "who to call" for future reference:

	NAME AND ADDRESS (Where Appropriate)	TELEPHONE
SUPERVISOR		
BOILER SERVICE – BREAKDOWN (Boiler Mechanic)		
BOILER SERVICE –CLEANING		
FUEL OIL DELIVERY		
LOCAL HARDWARE STORE		
FIRE DEPARTMENT		
ELECTRIC COMPANY		
DEPT. OF WATER SUPPLY, GAS & ELECTRICITY		

BASIC MAINTENANCE SUPPLIES

Here is a basic list of general supplies:

1. Broom
2. Dust Pan
3. Wooden Stick
4. Clean Cleaning Rags
5. Metal Scraper
6. Wrenches
7. Allen Wrenches
8. Pliers
9. Screwdrivers
10. Flashlight
11. Dipstick or Sounding Tape
12. Solvent (kerosene)
13. Heavy Cloth or Canvas
14. Heavy Duty Extension Cord
15. Disposal Can for Oily Rags
16. Equipment Manuals:

    ____
    ____
    ____
    ____
    ____

If you manually clean boiler tubes:

17. Vacuum Lance
18. Fibre Boiler Tube Brushes

List here the supplies from the top of this page which you do not have on hand and need to get:

______________________________ ______________________________
______________________________ ______________________________
______________________________ ______________________________
______________________________ ______________________________
______________________________ ______________________________
______________________________ ______________________________
______________________________ ______________________________
______________________________ ______________________________

REFERENCE SPECIFICATIONS

On the next two pages are charts which will give you easy access to information when you need it. If you have completed all of the pages before this one, you already have what you need.

FILL OUT THE CHARTS ON THE NEXT TWO PAGES where they apply to your system.

Get the information from pages 29 - 47.

SUPPLIES/REORDERING

ITEM	SPECIFICATIONS (Model No., Type, (Size, Wattage, etc)	SPARES TO HAVE ON HAND	COMPANY (Supplier) TELEPHONE NUMBER
ATOMIZING CUP		1	
BELTS FOR:			
Burner Motor		1	
Fuel Oil Pump		1	
Modulating Motor		1	
Primary Air Fan		1	
Other			
BULBS, LIGHTING		1 For every 5 bulbs in use	
FUEL OIL – #6	Burning Temperature:	5 days supply	
FUSES FOR:			
Boiler Plant Electric Circuits		2 of each	
Other			
GAUGES:			
Pressure Gauge		1	
Temperature Gauge		1	
Vacuum Gauge		1	
GAS PILOT – ELECTRODE	Size:	1	
LUBE OIL	Grade:		
OIL STRAINERS		1	
VACUUM TUBE (Master Control)		1	
WARP POINTS		1 set	

APPROPRIATE RANGE OR READINGS FOR THIS SYSTEM

	Reading/Range
Vacuum Gauge	
Pressure Gauge	
Steam Pressure Gauge (on boiler)	
Thermostat — Steam or Hot Water Oil Heater	
Thermostat — Electric Heater	
Atomizing Temperature	

EQUIPMENT SPECIFICATIONS

	Make	Model Number
Atomizing Cup		
Burner		
Flame Scanner		
Heaters:		
Electric Heater		
Steam/Hot Water Oil		
Motors:		
Burner Motor		
Draft Damper Motor		
Modulating Motor		
Other		
Oil Strainers		
Pumps:		
Fuel Oil Pump		
Other		

OPERATION AND MAINTENANCE SUMMARY

BOILER ROOM CLEAN–UP

Doors must lock
Oil slicks gone
Gauges easy to read

Tools put away
Air intakes clean
Garbage cleaned up

DAILY CHECKS

1. FUEL in the tank
2. WATER in the boiler
3. OIL TEMPERATURE – heater settings OK

FREQUENT CLEANING

1. SMOKE ALARM LENS
2. ATOMIZING CUP

Getting Ready
   1. Disconnect twist plugs and linkage
   2. Open latch
   3. Swing burner out
   4. Cover burner opening

Cleaning The Cup
   1. Clean cup with rag and solvent
   2. Remove deposits with wooden stick
   3. Spin cup to check for wobble.
   4. Check cup surface and edge for nicks

Other Checks
   1. Clean fuel nozzle
   2. Clean air cone around cup.

STARTING A COLD BOILER

Getting Ready
1. Check oil pressure gauge
2. Turn on fuel oil pump
3. Turn on electric heater

Check Burner
1. Inspect cup, clean if necessary
2. Swing burner into place
3. Reset linkage, lock in burner

After Start Checks
1. Flame
2. Oil Temperature
3. Oil Pressure

WEEKLY MAINTENANCE

1. CLEAN OIL STRAINERS

Single Basket
1. Turn off oil valve
2. Shut down boiler
3. Remove basket & clean
4. Replace basket
5. Open oil valve
6. Start boiler

Double Basket
1. Switch oil to empty basket
2. Remove dirty basket & clean
3. Replace basket

2. LUBRICATE WHERE NEEDED

MONTHLY MAINTENANCE

1. CLEAN BOILER TUBES

Please Stop!

Pages 54-57 will be filled out as you complete Sections 3 and 4. Please turn to page 65 and begin Section 2.

TROUBLESHOOTING REFERENCE

In this section are TROUBLESHOOTING TABLES which tell you exactly WHAT TO DO WHEN YOU GET SMOKE.

These pages will be completed with Troubleshooting, **Boilers**; **Sections 3 and 4**.

Then, use them as reference if your smoke alarm goes off.

TROUBLESHOOTING SUMMARY - GENERAL

CORRECTING OIL TEMPERATURE:

TROUBLESHOOTING CHECKS FOR:	ELECTRIC HEATER	HOT WATER OIL HEATER	STEAM HEATER
COLD OIL	1. Heater Switch on 2. Circuit Breakers closed 3. Oil Thermostat set and working 4. Heating Element working	1. Oil Thermostat 2. Pump - Motor	1. Steam Pressure Gauge - Boiler - 2 psi 2. Oil Thermostat 3. Steam Trap 4. Steam Regulator
OIL TOO HOT	1. Oil Thermostat 2. Warp Points	1. Oil Thermostat	1. Oil Thermostat 2. Steam Regulator

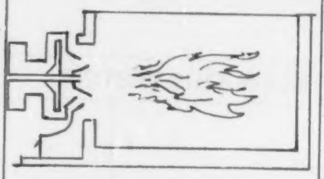
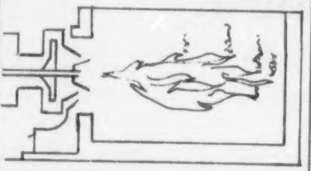
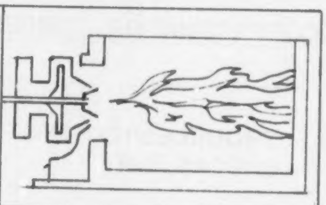
TROUBLESHOOTING THIS PARTICULAR SYSTEM

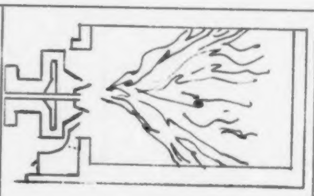
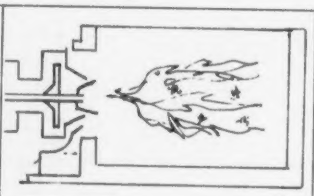
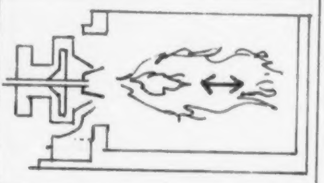
CORRECTING OIL TEMPERATURE:

TROUBLESHOOTING CHECKS FOR:	HEATERS ON THIS SYSTEM		
COLD OIL			
OIL TOO HOT			

TROUBLESHOOTING SUMMARY - GENERAL

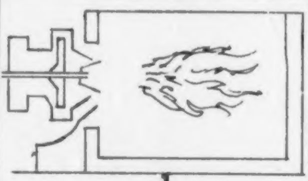
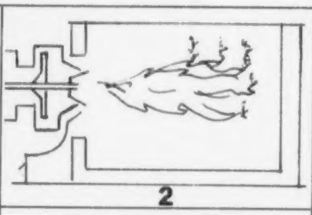
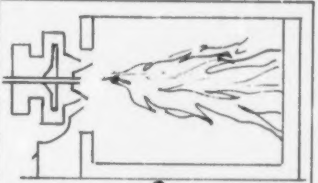
FLAME READING: Based on normal oil flow.

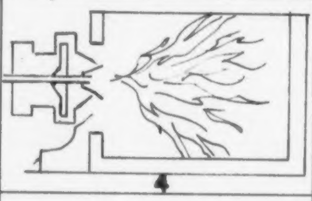
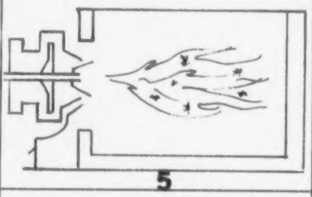
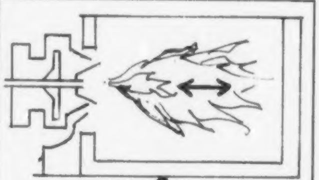
INCORRECT FLAME			
HOW INCORRECT	FLAME AWAY FROM BURNER	SMOKY FLAME	FLAME TOO LONG
POSSIBLE CAUSE	Too much Primary Air	Not enough air	Too much oil Incorrect cup position
CHECKS TO MAKE	Primary Air shutter, linkage, fan	Primary Air shutter, linkage Secondary Air Windbox, linkage Stack Damper	Oil Valves Burner Cup

INCORRECT FLAME			
HOW INCORRECT	FLAME TOO WIDE	SPARKY FLAME	PULSATING FLAME
POSSIBLE CAUSE	Too little primary air; Incorrect cup position	Oversized bits of oil and carbon	Oil amount incorrect Uneven oil flow Too little air
CHECKS TO MAKE	Primary Air shutter, linkage, fan Burner Cup	Cup - Clean, possible adjustment	Oil Temperature Oil Pressure Air Supplies

TROUBLESHOOTING THIS PARTICULAR SYSTEM

FLAME READING: Based on normal oil flow.

INCORRECT FLAME	 1	 2	 3
HOW INCORRECT	FLAME AWAY FROM BURNER	SMOKY FLAME	FLAME TOO LONG
POSSIBLE CAUSE(S)			
CHECKS TO MAKE			

INCORRECT FLAME	 4	 5	 6
HOW INCORRECT	FLAME TOO WIDE	SPARKY FLAME	PULSATING FLAME
POSSIBLE CAUSES(S)			
CHECKS TO MAKE			

On the following pages is a short glossary of words that apply to your boiler. This is for future reference. YOU DON'T HAVE TO DO ANYTHING ON THESE PAGES.

If you ever want to check on what a word means that has to do with the boiler, look here for its meaning.

GLOSSARY

A

ATOMIZE	To break into tiny bits or mist.
ATOMIZING CUP	Cone in the burner assembly which spins the oil into a mist for burning.

B

BOILER FIRETUBES	Tubes through which the heat from the furnace flows to heat the water in the boiler.
BREECHING	Connection (channel or pipe) from boiler to stack.
BTU	British Thermo Unit; the amount of heat necessary to raise the temperature of 1 lb. of water 1° F at or near maximum density.
BURNER COVER	Cover which should be used over burner opening when burner is swung out (venturi cover). Failure to cover opening might cause refractory to be damaged from cold air shock.
BURNER CUP	Atomizing cup; cup which spins the oil into a fine mist for burning.
BURNER HINGE	Joint(s) on which the burner can be swung away from the main boiler assembly.
BURNER MOTOR	Motor providing the power to spin the atomizing cup.

C

CHECK VALVES	A valve permitting oil to flow in one direction only; used to prevent oil from returning to the tank when the pump shuts down.
CIRCUIT BREAKER	Device for the automatic interruption of an electrical circuit when a problem occurs.
COMBUSTION	Burning; the interaction of oil with oxygen in air accompanied by a well defined flame releasing heat.
CONDENSATE	Water formed by cooling steam.

Preceding page blank

D

DAMPER	Device which checks or regulates the draft (air) flow.
DIAPHRAGM	Flat disk of metal or rubber which bends in response to pressure changes.
DIPSTICK	Long stick used to measure the depth of a liquid.
DRAFT	Air flow caused by chimney effect or by a blower (fan).
DRAFT CONTROLS	Ways of regulating the air flow.

E

EMISSION	Undesirable combustion products such as smoke, soot, SO_2 etc.

F

FAN CASING	The fan cover which permits access to the fan.
FIREBOX	The furnace; where combustion takes place.
FLAME ROD	Sensor inserted in the flame to establish and monitor proper ignition.
FLAME SCANNER	Sensor to establish or monitor proper ignition based on presence of ultra-violet rays; purple peeper.
FLASH POINT	Temperature (determined by laboratory test) which indicates the fire safety of the fuel.
FLUE GAS	Products of burning fuel.
FLUE GAS TEMPERATURE	Temperature of gases as they leave the boiler.
FUEL NOZZLE	Fitting at the end of the oil supply line which distributes the oil into the cup.

G

GRAVITY (specific)	The comparison of the ratio of the weight of a gallon of oil to a gallon of water; measured in degrees API (American Petroleum Institute); low gravity indicates heavy oil.

H

HEATERS	Equipment which raises the oil to the required temperature for pumping, flow, and burning; boiler systems are equipped with an electric heater and a steam or hot water oil heater.

I

IGNITION	The act of lighting fuel; light-off.
IMPINGEMENT	When flame touches refractories so as to impair combustion.

J

JUMPER	Means for cutting an electrical control out of the circuit.

L

LATCH-OUT SWITCH	Safety switch; device which protects the boiler by shutting down the system in the event of flame failure.
LOUVERS	Movable, multiple panels for controling air flow.
LOW WATER CUT-OFF	Automatically shuts off the burner when the water in the boiler is too low.

M

MAGNETIC OIL VALVE	Control which starts and stops oil from entering the atomizing cup.
MASTER CONTROLLER (programmer, Projector Relay)	Device on the main panel board which starts and stops the burner safely.
METERING VALVE	Automatic oil flow valve connected to the Primary and Secondary air dampers so that burner operation can be modulated.
MODULATING MOTOR	Motor that drives the linkages to oil and air valves.
MODULATION	Automatic matching of the burner oil input with the correct air flow to meet the heating demands of the building.

O

OIL PRESSURE	The force required to move the oil.
OIL PRESSURE GAUGE	Instrument used to measure oil pressure.
OIL TEMPERATURE INTERLOCK	Thermostatic control set to prevent the burner from operating until the oil reaches the proper viscosity for good combustion.
OIL TRANSFER PUMP	Motor driven pump providing the pressure required to move oil from the tank to the burner.

P

PARTICULATES	Any solid or liquid (other than water) which is so small as to be capable of being carried by the wind or suspended in air.
PHOTO CELL	The sensor which proves the presence of a flame, thus insuring a safe light-off.
PILOT	A gas burner used to light the main oil burner.
POST-PURGE	Continuing burner fan operation after the flame is shut off in order to clean any residual oil or gas vapors remaining in the boiler.
POUR POINT	Measure of the effect of temperature on the ability of oil to flow; is measured by cooling the oil until it just moves.
PRE-PURGE	Burner fan operation before ignition to insure absence of combustion vapors in the boiler.
PRESSURE RELIEF VALVE	Valve set at a pressure to permit the oil to return to the tank when not needed to meet the burner need.
PRIMARY AIR SHUTTER	Adjustable, automatic means of controling the primary air to the burner.
PSI	Pounds per Square Inch — a unit of pressure.
PULSATING	Rhythmic changing of the flame shape.

R

RATIO	The relation of one substance to another; in boilers the relation of the right amount of air to the right amount of oil is the proper air/oil ratio.
REFRACTORY	Special brick lining for the firebox in the boiler.
RELAY	Part of control system used to transfer electrical impulses.
RESET	Generally refers to the main overriding safety control valve; must be manually turned back on in the event of automatic shutdown.
RESIDUAL	Refinery term for the end product of oil processing; descriptive word for #6 oil.
RINGELMANN CHART	Chart used to measure the severity of air pollution by how dark the smoke is.
ROTARY CUP	Polished brass cone in burner which spins to atomize the oil.

S

SAFETY CONTROL SENSORS	Parts of the safety system located in the firebox and used to prove the existence of flames.
SCHEMATIC DIAGRAM	A diagram drawn to show the proper order and relation of things rather than how they actually look.
SECONDARY AIR	Air supply around the burner flame from the windbox.
SECONDARY AIR DAMPER	Damper on the windbox usually in the form of louvers to control secondary air flow.
SEDIMENT	Undesirable residues in oil.
SEQUENTIAL DRAFT CONTROLLER	A regulator in the breeching which adjusts stack draft.
SMOKE ALARM	Device in the breeching which responds to smoke by setting off an alarm.

SOLVENT	Organic liquid used for cleaning; usually kerosene or Stoddard's solvent.
SPINNING CUP	The atomizing cone in the burner.
STRAINERS	Large and fine mesh sieves in the oil lines which remove residue.
SUCTION BELL	Device in the storage tank where a limited amount of oil is heated for pumping.

T

TRIAL FOR IGNITION	Time period provided to complete the ignition cycle; normally about 10 seconds. If ignition does not take place within this time, the boiler shuts down (some systems permit a second trial).

V

VACUUM GAUGE	An oil pressure gauge on the oil line (on inlet side of pump) which indicates clogging of oil line.
VISCOSITY	A measure of the ability of oil to flow.

W

WINDBOX	A louvered cover designed to permit modulation of the secondary air flow.

Section 2
THE BASICS OF BOILER OPERATION AND MAINTENANCE

1. IS YOUR BOILER ROOM IN GOOD SHAPE?

Get your upgraded boiler room off to a good start and keep it clean!

DOORS MUST LOCK	Keep strangers out
OIL SLICKS GONE	Floor dry — no puddles or oil slicks
GAUGES EASY TO READ	Clean instruments
TOOLS PUT AWAY	You're bound to get hurt in a cluttered room
AIR INTAKES CLEAN	Never block outside air intakes
GARBAGE CLEANED UP	No mess

To be sure you've got it, fill in the blanks below:

________ must lock.
________ slicks gone.
________ easy to read.
________ put away.
________ intakes clean.
________ cleaned up.

Write the first letter of the first word of each sentence in this space: ____________________

Check your answers

Answers to Exercise 1: D O G T A G

See if DOGTAG will help you remember the six rules for keeping your boiler room in shape. Write them below.

D __________

O __________

G __________

T __________

A __________

G __________

Check and correct your answers from preceding page, then go to next exercise.

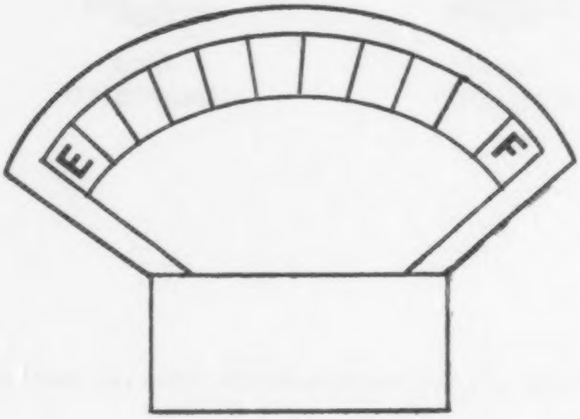
2. CHECK THESE THINGS EVERY DAY

To keep the boiler running right you'll need:

- **FUEL in the tank**
- **WATER in the boiler**
- **OIL hot enough to flow and burn properly**

FUEL

You should check your fuel gauge every day, especially in winter. Keep a five-day supply on hand. Draw a needle on the fuel gauge below showing a five-day supply of oil for you in winter (refer to Boiler Handbook you've started).



What is your fuel supplier's telephone number:

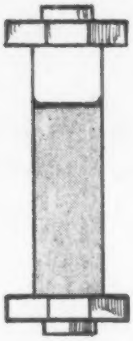
____

– Go on to next page

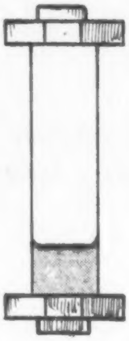
WATER

Check the water level by looking at the gauge glass on the outside of the boiler. If the gauge glass registers half full or more, there is enough water; add water if the glass registers under half.

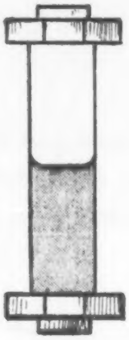
CIRCLE THE CORRECT WORD under each gauge glass below:



Water
OK/NEEDED



Water
OK/NEEDED



Water
OK/NEEDED

1. OK
2. NEEDED
3. OK

You would have to add water to the second glass only, one and three are OK. When you need water, what do you do?

Turn on feed pump: ________ **Open city water valve:** ________

Other: ____

(describe)

____

____

____

____

____

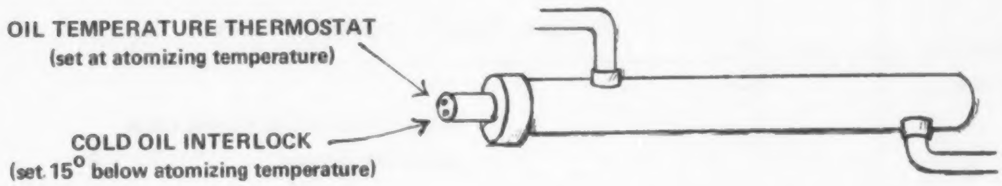
Go to next page

OIL TEMPERATURE (in electric heater)

Low-sulphur oil – like the kind you are burning now – atomizes at lower temperatures but still must be heated.

What is the atomization temperature you now use? ____________________

Here is an electric heater (with cap removed):


OIL TEMPERATURE THERMOSTAT
(set at atomizing temperature)
COLD OIL INTERLOCK
(set 15° below atomizing temperature)

CHECK EVERY DAY:

Thermostat – puts oil into burner at right temperature
Cold Oil Interlock – shuts burner down if oil is not hot enough

1. At what temperature should your oil temperature thermostat be set? ____________________

2. At what temperature should your cold oil interlock be set? ____________________

What are the three things to check each day? 3. ____________________

4. ____________________

5. ____________________

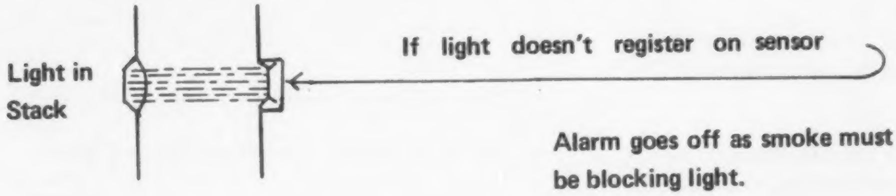
Check and correct
your answers.

1. atomizing temperature
2. 15° lower than thermostat
3. Fuel
4. Water
5. Oil Temperature

---

3. CLEAN YOUR SMOKE ALARM EVERY FEW DAYS – AT LEAST ONCE A WEEK

Here's how your smoke alarm works:

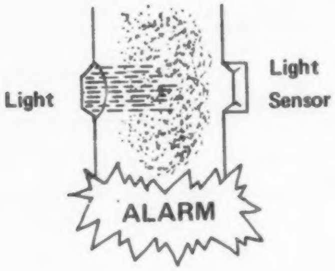


If light doesn't register on sensor

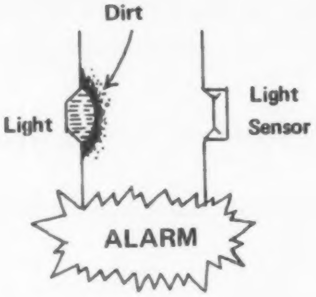
Alarm goes off as smoke must be blocking light.

The Smoke Alarm is going off at the two stacks below. Only one is really smoking.

CIRCLE THE CORRECT WORDS UNDER THE STACKS – if there is a true alarm or a false alarm.



TRUE/FALSE Alarm



TRUE/FALSE Alarm

The first picture shows what should happen with smoke. The light in the second picture does not get through to the sensor because of dirt on the lens and the alarm goes off when there is no smoke!

What must you do frequently to keep a false alarm from sounding? ______________________________

–Check and correct your answer

Answer to Exercise 3: Clean the smoke alarm lens.

4. REVIEW: DAILY BOILER TASKS

1. List the six things that keep your boiler room in good shape:

2. What three things must also be checked every day?

______ in the tank
______ in the boiler
______ hot enough to burn properly

3. On what piece of equipment must you check the settings of the oil temperature thermostat and the cold oil interlock?

4. What happens if smoke alarm lens is dirty? ______

Answers to Exercise 4:

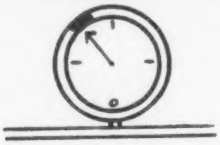
1. Doors must lock
   Oil slicks gone
   Gauges easy to read
   Tools put away
   Air intakes clean
   Garbage cleaned up
2. Fuel
   Water
   Oil
3. Electric Heater
4. False Alarm

5. GETTING READY TO START

You may have to start a cold boiler. First look at the OIL PRESSURE GAUGE. It is not working right if it shows a pressure reading when the system is off. Look at the gauges below.

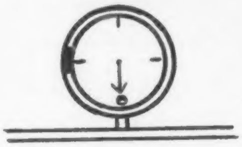
CIRCLE THE CORRECT WORDS UNDER EACH.

SYSTEM OFF



1. Gauge IS/IS NOT working correctly.

SYSTEM OFF

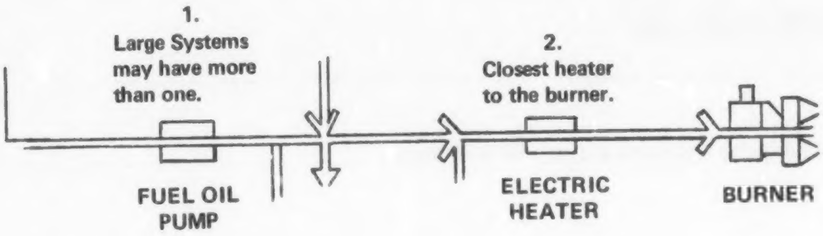


2. Gauge IS/IS NOT working correctly

1. The first gauge above is out of order. If you replace this gauge, keep a spare on hand.
2. **Gauge 2 is correct.**

TWO SWITCHES TO THROW:

Two more things must be turned on and given time to work before you start. Study the diagram, then answer the questions below:


1.
Large Systems may have more than one.
2.
Closest heater to the burner.
FUEL OIL PUMP
ELECTRIC HEATER
BURNER

1. What piece of equipment gets the oil up to proper burning temperature? ____________________
2. What piece of equipment moves the oil out of the tank to the burner? ____________________
3. What 2 pieces of equipment must be turned on before you can start the burner? ____________________

Check and correct
your answers.

Answers to Exercise 5:
1) Electric Heater
2) Fuel Oil Pump
3) Heater & Pump

---

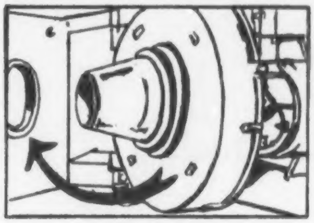
6. CHECK OUT THE BURNER

Burners on a manual stop/start schedule should be cleaned before shut-down and left with the burner out of the furnace (with the furnace opening covered). Before starting up the burner again, do these three things:

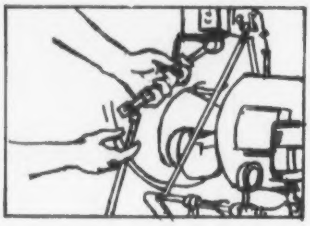
1. Inspect burner cup and clean if necessary.
2. Swing burner assembly into furnace.
3. Reset linkage, lock burner in position.

Correct linkage settings are important; they control the air/oil ratio. Mark the settings so that you can reset them perfectly each time.

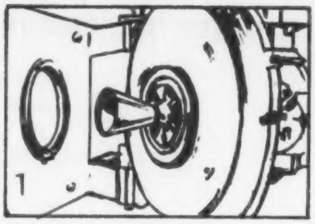
A. Study the three pictures. Write the number and description from above of the step it shows:



____
____
into furnace.



____
___________ lock burner
in position.



____
________________ and
clean if nescessary.

B. Answer these questions:

What do you get if the burner cup is dirty? ______________________________

What do you get if the air/oil ratio is wrong? ______________________________

Check and correct
your answers .

Answers to Exercise 6:

A. 2. Swing burner assembly back into furnace
3. Reset linkage, lock burner in position.
1. Inspect burner cup, clean if necessary

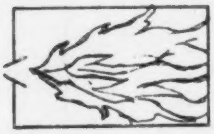
B. Smoke
Smoke

---

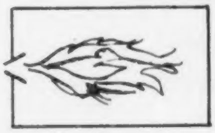
7. FIFTEEN MINUTES LATER

1. CHECK THE FLAME

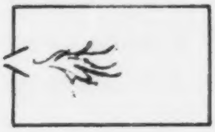
Remember a good flame? CIRCLE GOOD or BAD under each flame, whichever is true:



GOOD/BAD



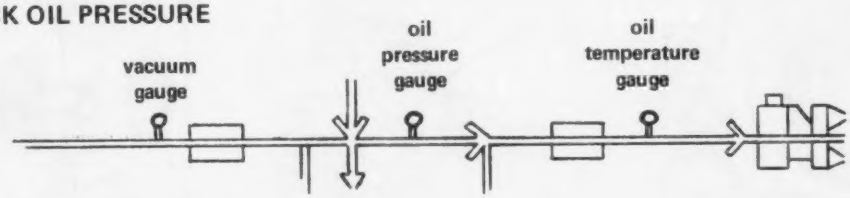
GOOD/BAD



GOOD/BAD

A good flame is a steady, orange one which fills the furnace but does not touch the walls, like the middle one above.

2. CHECK OIL TEMPERATURE AND
3. CHECK OIL PRESSURE



The oil temperature and pressure right for your boiler will depend on the oil you are using.

1. What instrument in the diagram checks oil temperature? ____________________

2. What instruments in the diagram let you check the oil pressure? (more than one) ____________________

About 15 minutes after your boiler has been operating, what basic things should you check?

3. ____
4. ____
5. ____

If you find any of these out of line, you will follow troubleshooting guides that will appear later in this program.

Check and correct
your answers ⇩

Answers to Exercise 7:

1. **Oil Temperature Gauge (thermometers, aquastats)**
2. **Pressure Gauge, Vacuum Gauge**
3. **The Flame**
4. **Oil Temperature**
5. **Oil Pressure**

8. REVIEW: DAILY BOILER TASKS & COLD STARTS

1. What key word reminds you of the six checks you should make in the boiler room every day?

   ____

2. What two settings on the electric heater should be checked every day?

   ____

3. How many days fuel supply should you have on hand at all times?

   ____

4. Check the ______________ in the boiler every day.

5. Before turning on the burner, check the ______________ gauge.

6. Before turning on the burner, what two pieces of equipment must be turned on?

   ____

7. What three things should be checked after the boiler has been running for 15 minutes?

   ____

   ____

   ____

Check and correct
your answers ⇩

Answers to Exercise 8:

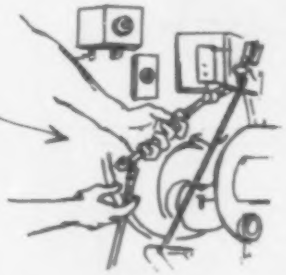
1. DOGTAG
2. Oil Temperature Thermostat, Cold Oil Interlock
3. 5 Days
4. Water
5. Oil Pressure
6. Fuel Pump, Electric Heater
7. Flame
   Oil Temperature
   Oil Pressure

9. CLEANING THE CUP

The burner cup should be: CLEAN
UNDAMAGED
and SPIN PERFECTLY

Check the cup when it is HOT and the oil is still LOOSE. Plan a convenient time to do this every few days, at least once a week.

OPENING THE BURNER — Remember accurate linkage setting.



WHEN DISCONNECTING RIGID LINKAGE

Mark settings if necessary so replacement is accurate.

After the burner is out, cover the opening. Cool air will weaken or crack the refractory walls.

NUMBER THE FOLLOWING in the correct order:

______ Swing burner out
______ Open latch
______ Cover burner opening
______ Disconnect twist plugs ("dogs") and linkage

1. How could you lose the proper air/oil ratio when cleaning the cup? ______________________________

2. How could you damage the refractory when cleaning the cup? ______________________________

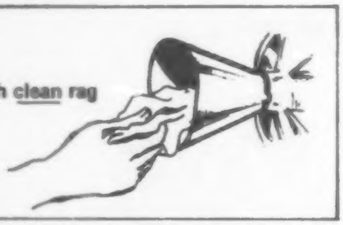
Check and correct
your answers.

3
2
4
1

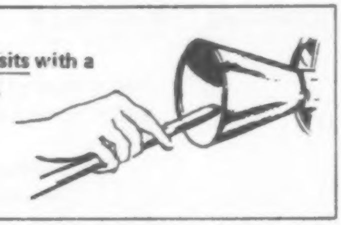
1. by not marking the linkage
2. by not covering the furnace opening

CLEANING THE CUP

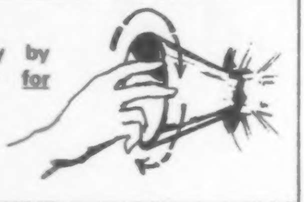
Use materials that will not scratch it.



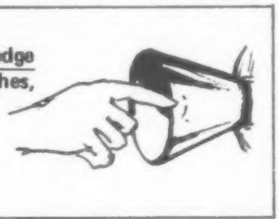
1. Wipe cup with clean rag and solvent.



2. Remove deposits with a wooden stick.



3. Spin cup slowly by hand to check for wobble.



4. Check surface and edge for nicks, scratches, dents.

Wobble in the cup (3 above) often means that the shaft or cup is bent. Call Service.

A nick on the cup surface or edge (4 above), even small, will cause a problem in atomization. Call Service.

1. Why must you use a clean cloth to clean the cup? ______________________________

2. What do you do with a wooden stick? ______________________________

3. How do you check for wobble? ______________________________

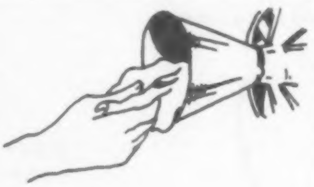
4. Will a small scratch or nick on the edge cause a noticable problem? ______________________________

Check and correct
your answers

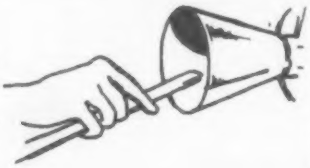
1. A dirty cloth will scratch the cup
2. Remove deposits on cup
3. Spin cup slowly by hand
4. Yes

COMPLETE THE PROCEDURE FOR CLEANING THE CUP:

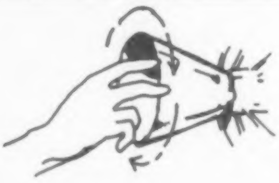
1. ______________
____
with rag
and solvent.



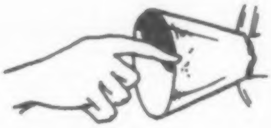
2. ______________
____
with wooden
stick.



3. Spin cup
to check
____
____



4. ______________
____
for nicks,
scratches,
dents.



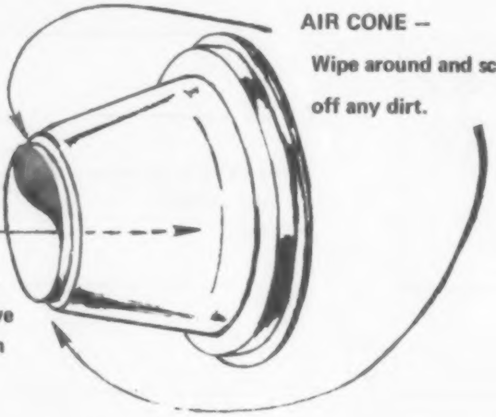
**Check and correct
your answers.**

Cup Cleaning Procedure:

1. Wipe cup
2. Remove deposits
3. For wobble
4. Check surface and edge

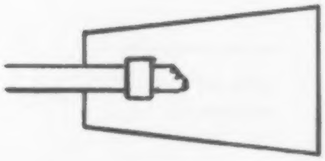
CHECK IN AND AROUND CUP

CLEAN AIR AND OIL INPUT



AIR CONE –
Wipe around and scrape off any dirt.

FUEL NOZZLE
If you have a fine mesh strainer, clean the nozzle in place. If not, remove the nozzle and clean in solvent.



Now, the burner is ready to go again.

Answer these questions with regard to your system:

1. What might collect in the fuel nozzle? ____________________

2. Is it sufficient to clean your fuel nozzle in place or must you remove it? ____________________

3. What might collect in the air cone? ____________________

Check and correct
your answers.

1. Dirt in the oil
2. Yes, if you have a fine mesh strainer, otherwise no
3. Dirt in the air or from the fan

CUP CLEANING REVIEW

1. The cup should be cleaned when it is (hot, cold). ____________________

2. In opening the burner to clean the cup, what two things should you be careful of to avoid smoke and/or damage to your boiler?

____

____

3. Complete the four things to do or check in cleaning the cup?

   1. ____________ with rag and solvent.
   2. ____________ with wooden stick.
   3. ____________ by spinning the cup.
   4. ____________ for nicks, scratches.

4. What two other cup related things do you clean after cup cleaning?

____

____

Check and correct
your answers. ▽

Answers – Cup Cleaning Review

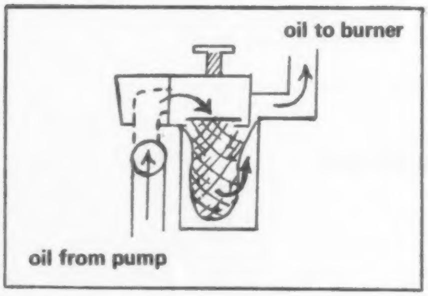
1. Hot
2. Mark your linkage settings
   Cover the burner opening
3. Clean the cup
   Remove deposits
   Check for wobble
   Check edge and surface
4. Fuel nozzle
   Air cone around cup

10. CLEAN OIL STRAINERS ONCE A WEEK

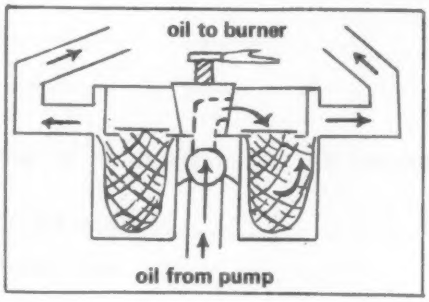
You need to keep your oil strainers clean, in order to have clean oil and a good flame.

Most systems have two strainers. They may be either single basket or double basket.

CIRCLE THE CORRECT WORDS UNDER EACH PICTURE:



1. SINGLE/DOUBLE BASKET



2. SINGLE/DOUBLE BASKET

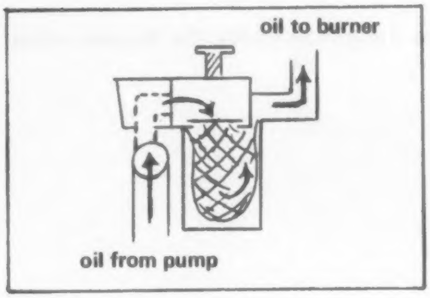
Check and correct
your answers ⇩

1. Single
2. Double

You may have single baskets (as in the first picture), double baskets (as in the second picture) or both.

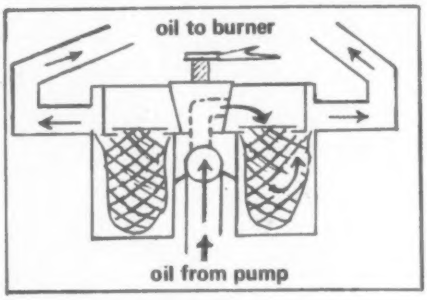
How many strainers do you have? ____________________
Are they single or double basket? ____________________

CLEAN EACH DIFFERENTLY



SINGLE BASKET CLEANING

1. TURN OFF OIL VALVE
2. SHUT DOWN BOILER
3. TAKE OUT BASKET and CLEAN
4. REPLACE BASKET
5. OPEN OIL VALVE
6. START BOILER



DOUBLE BASKET CLEANING

1. SWITCH OIL to empty basket
2. TAKE OUT DIRTY BASKET and CLEAN
3. REPLACE BASKET
   (empty basket clean)

Answer these questions:

1. With what kind of strainer must you shut down the oil flow and boiler? ____________________
2. With what kind of strainer can you keep oil flowing while cleaning a basket? ____________________
3. How do you keep oil from being in the single basket strainer while cleaning it? ____________________
4. Do you need to shut down your boiler to clean your strainer(s)? ____________________

Check and correct
your answers.

1. Single basket
2. Double basket
3. Turn off the preceding oil valve
4. Check your own answer

Clean strainers with a wire brush and solvent (kerosene). Place something under the strainer when cleaning to avoid dripping oil on the floor.

Complete the procedure for cleaning the strainers below:

SINGLE STRAINER

1. Turn off _______ valve.
2. Shut down ___________________.
3. Take out ___________ and clean.
4. Replace _______________________.
5. ____________ oil valve.
6. _____________ boiler.

DOUBLE STRAINER

1. Switch ___________ to empty basket.
2. Take out dirty ___________ and clean.
3. Replace __________________________.

Check and correct
your answers.

Single Strainer

1. Turn off oil valve
2. Shut down system
3. Take out basket and clean
4. Replace basket
5. Open oil valve
6. Start boiler

Double Strainer

1. Switch oil to empty basket
2. Take out dirty basket and clean
3. Replace basket

---

11. LUBRICATE EACH WEEK

Weekly lubrication is necessary for a smooth running system.

Check and lubricate if necessary:

EQUIPMENT	PROCEDURE
1. Burner Gear Case	Check oil level (visually or with finger) and add oil if reservoir not full
2. Motors	1 or 2 drops at oiling points for bearings
3. Linkage Joints	1 or 2 drops

Answer the following questions:

1. What equipment usually has a lube oil level indicator showing if oil is needed? ____________
2. Do not over oil bearings and joints. How much is needed? ____________
3. List the equipment in your boiler system needing lubrication:

____________ ____________

____________ ____________

Check and correct your answers.

1. Burner Motor Gear Case
2. 1 or 2 drops
3. Check your own answers

---

12. WEEKLY MAINTENANCE SUMMARY

WEEKLY TASKS: CLEAN OIL STRAINERS

LUBRICATE

CIRCLE THE CORRECT underlined words below:

1. The boiler should/need not be shut down when cleaning a single basket oil strainer.

2. In a double basket oil strainer the oil is always flowing through one/both of the baskets.

3. You may need to lubricate:gear case/all motors/switches on control panel/linkage joints.

Check and correct
your answers.

1. should
2. one
3. gear case/all motors/linkage joints

---

13. HOW ARE YOUR TUBES CLEANED?

If you have an automatic soot blower you can easily blow your tubes. If not, they must be cleaned manually.

If you clean manually, check every month and punch the tubes when soot builds up about 1/8 inch.

CLEANING METHOD	INSPECT	PERFORMED BY
Automatic Soot Blower	Every two weeks	Boiler Operator
Manual Cleaning	Every month	Boiler Operatory/ Contract Maintenance

1. How are your tubes cleaned? ____________________

2. How often do you need to inspect them? ____________________

3. Who cleans your boiler tubes? ____________________

Check and correct
your answers.

1. Automatic soot blower or by hand
2. Every two weeks (automatic), every month (manually)
3. Me or maintenance service

---

14. DO YOU HAVE AN AUTOMATIC SOOT BLOWER?

If you have an automatic soot blower, this page will give you the basics. If you don't have one, turn to the next exercise.

Blow your tubes during daylight hours, while the boiler is running, and about once every two weeks.

Start the AIR COMPRESSOR and let it reach the 50 # – 100 # range. The SMOKE ALARM should be turned off and the AIR CONTROL VALVE opened for the system to blow automatically.

The smoke alarm is turned off because soot blown from the tubes would set it off when you don't want it to.

Number these steps in the right order:

____ Start air compressor
____ Blow tubes (open air valve)
____ Turn smoke alarm off
____ Turn smoke alarm on
____ Shut off air compressor

Check and correct
your answers.

1 Start air compressor
3 Blow tubes (open air valve)
2 Turn smoke alarm off
5 Turn smoke alarm on
4 Shut off air compressor

---

15. PUNCHING THE TUBES

Either you or contracted maintenance will clean or **punch** tubes.

GETTING READY:

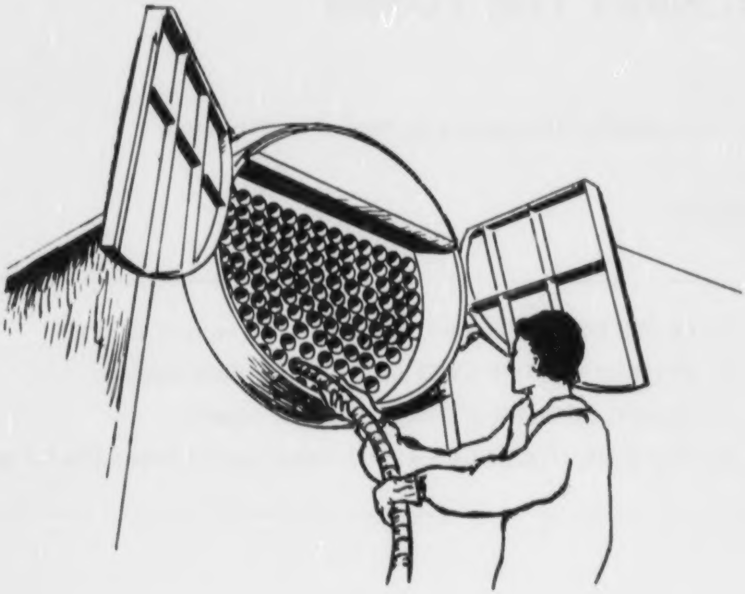
1. CLOSE DAMPERS manually or set draft control at zero.
2. SHUT DOWN THE SYSTEM 1/2 hour before cleaning.
3. COVER BURNER with heavy cloth or canvas.
4. PROVIDE TRASH CANS lined with plastic or paper bags for soot.

Which of the above (1, 2, 3, 4) is particularly important when you realize:

1. That tubes and clean-out doors are often located directly over the burner. ____________
2. The difficulty in handling loose soot. ____________
3. That the boiler is hot inside! ____________
4. Moving air in the tubes will send billows of soot through the clean-out door when it's open. ____________

Check and correct
your answers.

1. 3
2. 4
3. 2
4. 1



Clean your boiler tubes with a **WIRE BRUSH** attached to a **VACUUM LANCE**, carefully pulling the soot toward you into a lined trash can. Avoid getting soot into the stack, breeching or burner.

Number manual tube cleaning steps in the right order:

______ Clean tubes and close cleanout door.
______ Tie necks of can liners and put out for removal.
______ Getting Ready — shut burner down 1/2 hour before cleaning
close dampers
cover burner
provide trash cans with liners
______ Remove cloth from burner; put equipment away.

Check and correct
your answers

2

4

1

3

---

16. TUBE CLEANING REVIEW

AUTOMATIC SOOT BLOWING STEPS:

1. Start air compressor
2. Turn off smoke alarm
3. Blow tubes (open air valve)
4. Shut off air compressor
5. Turn smoke alarm on

MANUAL TUBE CLEANING STEPS:

1. Getting Ready: Shut burner down 1/2 hr. before cleaning
   close dampers
   cover burner
   provide trash cans with liners
2. Clean tubes and close clean-out door
3. Remove cloth from burner; put equipment away
4. Tie necks of can liners and put out for removal

LIST THE STEPS YOU TAKE when cleaning your tubes:

____

____

____

____

____

____

____

____

____

____

____

OPERATION AND MAINTENANCE SUMMARY

Below is a summary of the tasks included in this section.
They are listed in your Boiler Handbook for future reference.

BOILER ROOM CLEAN–UP

Doors must lock
Oil slicks gone
Gauges easy to read

Tools put away
Air intakes clean
Garbage cleaned up

DAILY CHECKS

1. FUEL in the tank
2. WATER in the boiler
3. HEATER SETTINGS – Oil Thermostat and Cold Oil Interlock

FREQUENT CLEANING

1. SMOKE ALARM LENS
2. ATOMIZING CUP

Getting Ready
1. Disconnect twist plugs and linkage
2. Open latch
3. Swing burner out
4. Cover burner opening

Cleaning the Cup
1. Clean cup with rag and solvent
2. Remove deposits with wooden stick
3. Spin cup to check for wobble
4. Check cup surface and edge for nicks

Other Checks
1. Clean fuel nozzle
2. Clean air cone around cup

STARTING A COLD BOILER

Getting Ready

1. Check oil pressure gauge
2. Turn on fuel oil pump
3. Turn on electric heater

Check Burner

1. Inspect cup, clean if necessary
2. Swing burner into place
3. Reset linkage, lock in burner

After Start Checks

1. Flame
2. Oil Temperature
3. Oil Pressure

WEEKLY MAINTENANCE

1. CLEAN OIL STRAINERS

SINGLE BASKET

1. Turn off oil valve
2. Shut down boiler
3. Remove basket and clean
4. Replace basket
5. Open oil valve
6. Start boiler

DOUBLE BASKET

1. Switch oil to empty basket
2. Remove dirty basket and clean
3. Replace basket

2. LUBRICATE WHERE NEEDED

MONTHLY MAINTENANCE

1. CLEAN BOILER TUBES

SUMMARY

These questions review the important things in this section:

1. **What basic supply should you check in the boiler each day? (Without it the boiler cannot operate.)** ____________________
2. **What basic supply to the burner should you check each day? (Without it the burner cannot operate.)** ____________________
3. **What should you check each day to be sure of good oil flow and proper burn?** ____________________
4. **What should you clean frequently to guard against a false smoke alarm?** ____________________
5. **Which heater do you need to turn on and heat up when starting a cold boiler?** ____________________
6. **What piece of equipment moves the oil and must be turned on when starting a cold boiler?** ____________________
7. **What instruments let you check the oil temperature?** ____________________
8. **What does the oil pressure gauge and the vacuum gauge let you check?** ____________________
9. **When cleaning the atomizing cup, should you use a wooden or metal stick to scrape off deposits?** ____________________
10. **Will a 1/4" or smaller nick on the cup surface hurt proper atomization?** ____________________

11. What will you prevent by using a clean cloth with solvent in cleaning the cup? ____________________

12. When cleaning the cup, what are you checking for when you give it a spin? ____________________

13. Dirt build-up should be removed from what two places in and around the cup? ____________________
____

14. Must the oil flow be turned off when cleaning a single basket strainer? ____________________

15. Must the oil flow be turned off when cleaning a double basket strainer? ____________________

16. What should be done about once a week to be sure that motors and linkage joints operate smoothly? ____________________

17. Should boiler tubes be cleaned on the average of once a week, once a month, or once a year? ____________________

18. What are the two methods or ways of cleaning the boiler tubes? ____________________
____

Check your answers.

ANSWERS TO REVIEW QUESTIONS

1. water
2. oil
3. oil temperature
4. smoke alarm lens
5. electric heater
6. pump
7. oil temperature gauges
8. oil pressure
9. wooden
10. yes
11. cup damage (scratches, poor atomization, smoke)
12. wobble
13. fuel nozzle in cup
    air cone around cup
14. yes
15. no
16. lubrication
17. once a month
18. manual cleaning
    automatic soot blower

Section 3

TROUBLESHOOTING BOILERS; CORRECTING OIL TEMPERATURE

1. SMOKE: WHAT TO DO WHEN THE SMOKE ALARM GOES OFF

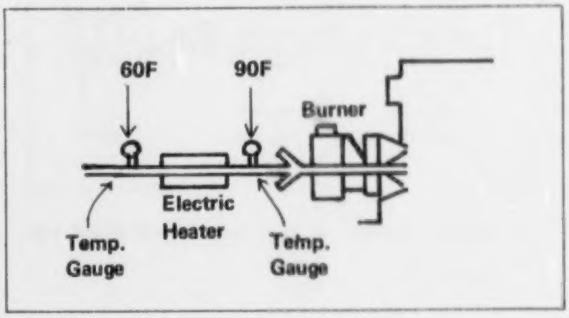
INCORRECT OIL TEMPERATURE IS THE BIGGEST CAUSE OF SMOKE. Check this first.

Correct temperature depends on the oil being used.

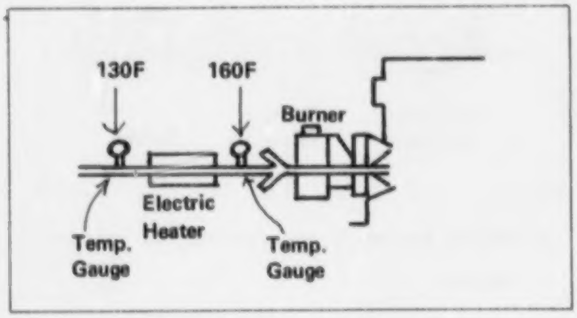
Look at the temperature gauge NEAREST THE BURNER. It should MATCH your ATOMIZING TEMPERATURE.

Suppose that: Atomizing temperature = 160 F.
All oil temperature gauges are working.

CIRCLE THE CORRECT WORD(S) UNDER EACH DIAGRAM.


60F
90F
Burner
Electric Heater
Temp. Gauge
Temp. Gauge

Oil Temperature IS/IS NOT correct.


130F
160F
Burner
Electric Heater
Temp. Gauge
Temp. Gauge

Oil Temperature IS/IS NOT correct.

In the first diagram, the oil nearest the burner IS NOT correct. It is 70° below atomizing temperature. This means an oil heating problem. The oil temperature is A–OK in the second diagram.

What is the biggest cause of a smoking boiler? ______________________________

– Check your answer.

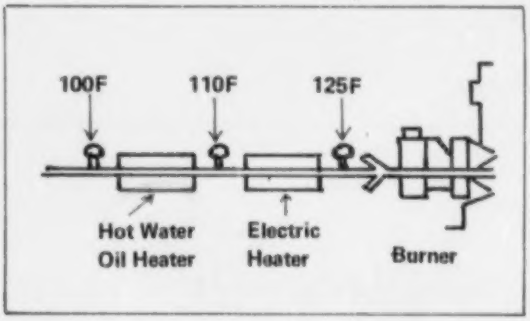
Incorrect oil temperature

If the oil temperature is wrong, locate the trouble spot by checking the OIL TEMPERATURE AT EACH HEATER. In a line of several heaters, trouble in the first may throw them all off.

What is normal for your heaters is in your Boiler Handbook.

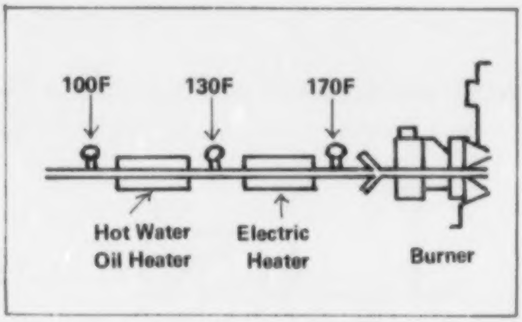
Suppose these temperatures are normal for the heaters below:

Tank Heating Coil Output – 100 F
Hot Water Oil Heater Output – 130 F
Electric Heater Output – 160 F
The Oil Temperature Gauges are working.


100F
110F
125F
Hot Water Oil Heater
Electric Heater
Burner

1. Which heater is not heating the oil correctly?

____


100F
130F
170F
Hot Water Oil Heater
Electric Heater
Burner

2. Which heater is not heating the oil correctly?

____

– Check your answers.

1. **Hot Water Oil Heater (too cold)**
2. **Electric Oil Heater (too hot)**

A SMOKE ALARM!

1. **What is the biggest cause of smoke?** ______________________________

2. **Which oil temperature gauge should you look at first?** ______________________________

3. **If the oil temperature is wrong, check each individual . . .** ______________________________

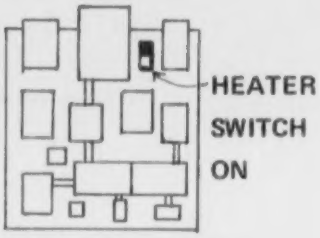
– Check your answers.

1. incorrect oil temperature
2. one nearest the burner
3. heater

---

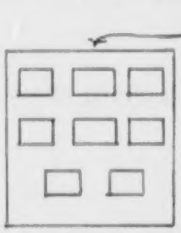
2. ELECTRIC HEATER - COLD OIL

If the electric heater isn't heating – check TWO BASICS to be sure it is on!



CONTROL BOARD

CIRCUIT BREAKERS CLOSED



ELECTRIC SUPPLY

Know which
circuit each
breaker monitors.

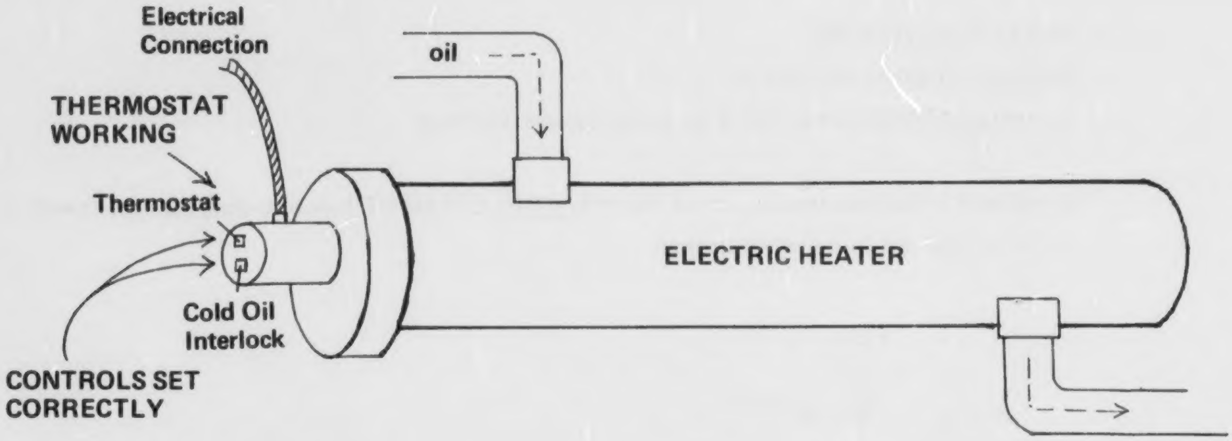
Your Electric Heater switch may be on your control board or on the Electric Heater. The circuit breaker location varies with each situation.

1. If the circuit breaker is open or switch off, will the electric heater work? ______________________
2. Where is your electric heater switch? ______________________
3. Where are the fuses or circuit breakers on your system? ______________________

– Check your answers.

1. No
2. Check your own answer
3. Check you own answer

If the Electric Heater is on – check the TEMPERATURE CONTROL.


Electrical Connection
oil
THERMOSTAT WORKING
Thermostat
ELECTRIC HEATER
Cold Oil Interlock
CONTROLS SET CORRECTLY

The thermostat should be set at the atomizing temperature with the cold oil interlock 15° lower.

The oil should change temperature when the thermostat setting is changed if the thermostat is working.

You or service may replace the thermostat if it is broken.

If the thermostat is working, what should happen when you turn it up? ____________________

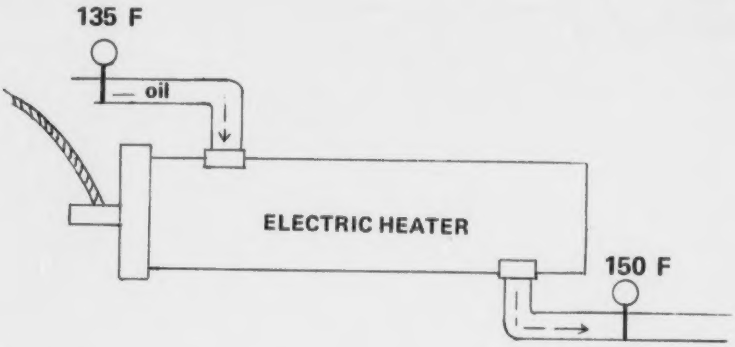
– Check your answer.

oil gets hotter

CHECK OFF (✓) the three troubleshooting steps seen so far: (cold oil in electric heater).

___ HEATER SWITCH ON?
___ CIRCUIT BREAKERS closed?
___ TERMPERATURE CONTROLS set correctly and working?

If you don't find the trouble, check the HEATING ELEMENT before calling service. It will no doubt be replaced by service if broken.



Did the oil temperature go up in this heater? ______________________

If the temperature goes up (as above), you know the HEATING ELEMENT IS WORKING.

What do you do if you find the heating element not operating? ______________________

– Check your answer.

call service for replacement

____

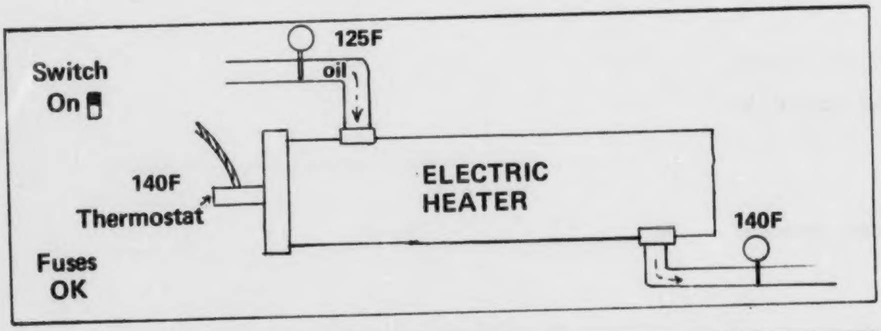
COMPLETE THE TROUBLESHOOTING STEPS for COLD OIL in the ELECTRIC HEATER.

1. Heater ______________ on.
2. ________________ breakers closed.
3. ________________ controls set correctly and working.
4. ________________ element working.

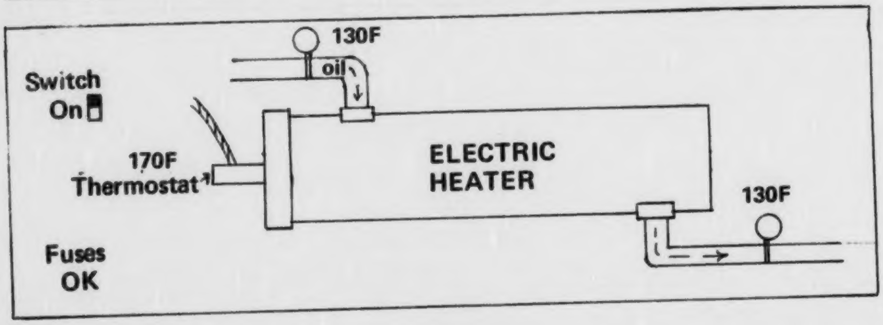
These all appear on the previous page. Check your answers and correct them if necessary.

SOME SMOKING BOILERS!

Below are two smoking boilers caused by cold oil coming from the Electric Heater. Beside each write what the probable problem is. Assume the correct atomizing temperature to be 170 F. All oil temperature gauges are working.


125F
oil
Switch
On
140F
Thermostat
ELECTRIC
HEATER
140F
Fuses
OK

1. PROBLEM: ______________________


130F
oil
Switch
On
170F
Thermostat
ELECTRIC
HEATER
130F
Fuses
OK

2. PROBLEM: ______________________

ANSWERS TO COLD BOILER PROBLEMS:

1. Thermostat needs to be reset.
2. Heating element not working.

---

3. ELECTRIC HEATER - OIL TOO HOT

Two things could be causing the Electric Heater to over heat.

1. THERMOSTAT – Is it set correctly? Is it working properly?

2. WARP POINTS (inside the thermostat) – Are they sticking together? If they are, they must be replaced (by you or service).

If these two checks don't solve the problem, call service.

ANSWER THESE QUESTIONS (assume oil temperature gauge OK):

1. What instrument shows that there is a hot oil problem in the Electric Heater? ____________________

2. When you first find hot oil in the Electric Heater, what control setting should be checked? ____________________

3. Have your warp points ever been replaced? ____________________

   If so, who did it? ____________________

1. Oil temperature gauge after the Electric Heater
2. Oil thermostat
3. Check your own answer

When you get hot oil in the Electric Heater, what two things should you check before calling service?

1. ______________________________
2. ______________________________

Check and correct
your answers ⇩

1. Thermostat (reset or repair)
2. Warp Points

HANDBOOK SUMMARY

TURN TO PAGE 54 , YOUR BOILER HANDBOOK.

On Page 54 is a summary of how to Troubleshoot Cold and Hot Oil in the heaters. Use this as reference.

IF YOU HAVE AN ELECTRIC HEATER, TURN TO PAGE 55 IN THE BOILER HANDBOOK.

Write ELECTRIC HEATER at the top of the first column on the table, under "Heaters on this system".

Under Electric Heater, list the COLD OIL CHECKS and HOT OIL CHECKS YOU HAVE JUST LEARNED.

4. COLD OIL FROM THE HOT WATER OIL HEATER

If you get COLD OIL from the HOT WATER OIL HEATER, check –

1. **THERMOSTAT on heater for incorrect setting or breakage.**

   To check for breakage, change the thermostat setting, wait, and see if it changes the oil temperature.

2. **WATER PUMP and its MOTOR**

   If you have them, check out what you can and call service if they are not operating.

Oil cannot be heated without these two essentials.

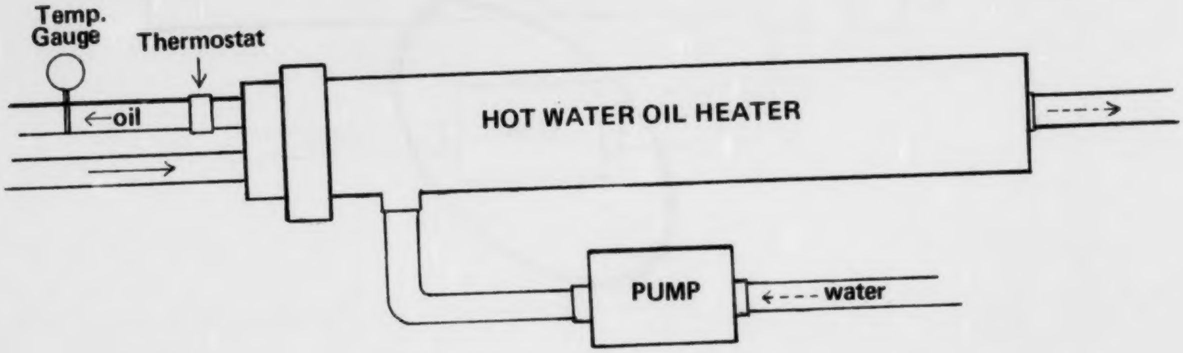
1. **Which of the above parts determines the temperature of the oil?** ______________________

2. **Which of the above delivers hot water to heat the oil?** ______________________

– Check your answers.

1. Thermostat
2. Pump, Motor

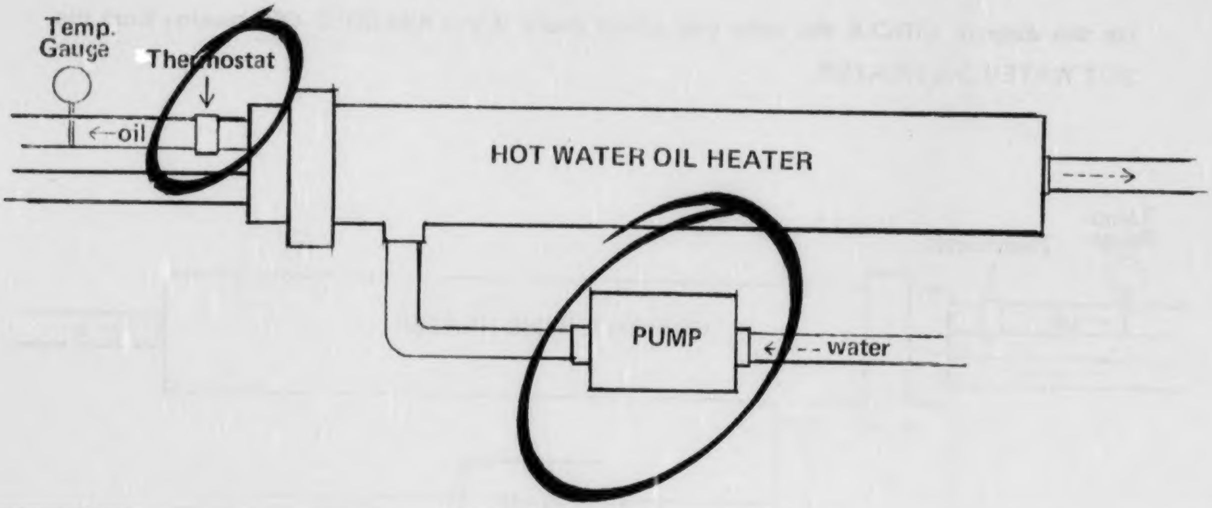
On this diagram CIRCLE the parts you would check if you had COLD OIL coming from the HOT WATER OIL HEATER.



Temp. Gauge
Thermostat
←oil
HOT WATER OIL HEATER
PUMP
← - - - water

If none of these adjustments solve the problem — call service.

— Check your answers.


Temp. Gauge
Thermostat
oil
HOT WATER OIL HEATER
PUMP
water

5. HOT WATER OIL HEATER – OIL TOO HOT

There is only one check to make before calling service if you get hot oil here.

THERMOSTAT	**Check for correct setting or if it is out-of-order.**

1. **Does your system use a hot water oil heater?** ____________________
2. **What is the normal thermostat setting for your hot water oil heater?** ____________________

– Check your answers.

1. Check your own answer
2. You should have this in your Boiler Handbook.

---

1. If you find HOT OIL in your HOT WATER OIL HEATER, what should you check before calling service?

   ____

2. If you find COLD OIL in your HOT WATER OIL HEATER, what should you check before calling service?

   ____

   ____

Check and correct
your answers ⇩

1. Thermostat
2. Thermostat
   Pump, Motor

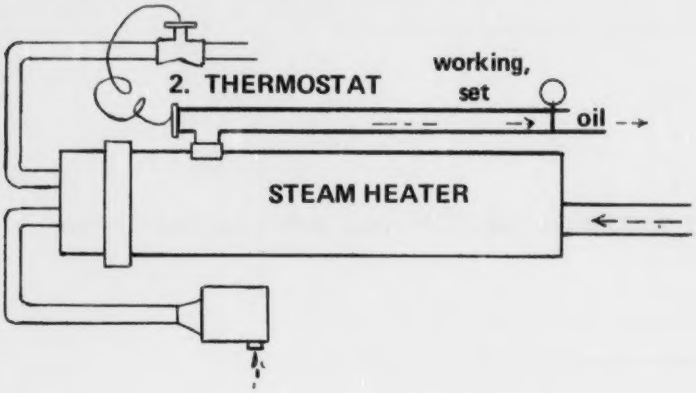
HANDBOOK SUMMARY

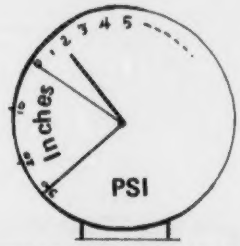
TURN TO PAGE 55,YOUR BOILER HANDBOOK.

Write HOT WATER OIL HEATER at the top of the second column if you have one. In this column, WRITE THE COLD AND HOT OIL TROUBLESHOOTING CHECKS just covered.

6. COLD OIL FROM THE STEAM HEATER

You may have a Steam Oil Heater. CHECK THESE PARTS if you find COLD OIL there.


2. THERMOSTAT
working, set
oil
STEAM HEATER


1 2 3 4 5
10
20
Inches
PSI

1. STEAM PRESSURE GAUGE
On boiler
Approx. 2 psi

If the STEAM PRESSURE in the boiler is all right, check the THERMOSTAT for your correct setting.

ANSWER THESE QUESTIONS:

1. What instrument tells you if you have steam in the boiler or not? ______________________________

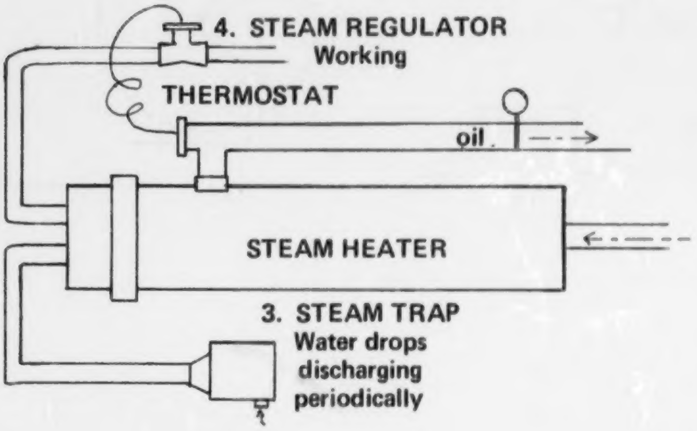
2. What is the approximate boiler steam pressure that you need to heat oil? (see gauge above) ______________________________

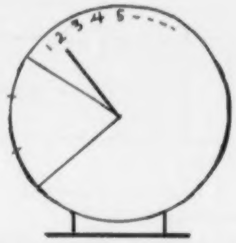
3. If you get cold oil in your Steam Heater, what are the first two things to check? ______________________________

– Check your answers.

1. Steam Gauge
2. 2 p.s.i.
3. Steam Gauge, Thermostat

Here are two more checks to make if you get cold oil.


4. STEAM REGULATOR
Working
THERMOSTAT
oil
STEAM HEATER
3. STEAM TRAP
Water drops
discharging
periodically



STEAM PRESSURE GAUGE

The heater discharges condensate (water drops) normally through the STEAM TRAP. If it is discharging steam, something is out-of-order.

The Thermostat is connected to the STEAM REGULATOR and regulates it. Check it for proper operation.

If these steps don't solve cold oil in the STEAM HEATER, call service.

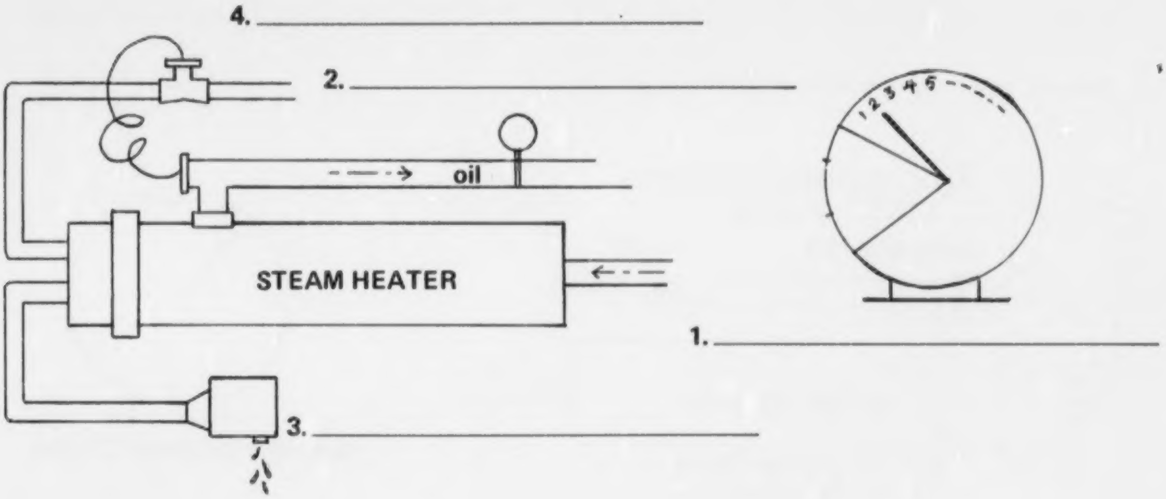
1. How can you tell that the steam trap is working satisfactorily? ________________________

2. What device does the thermostat control to let the right amount of steam into the heater? ________________________

– Check your answers.

1. Water drops discharge periodically
2. Steam Regulator

LABEL THE FOUR CHECKS to make on a steam heater delivering cold oil.

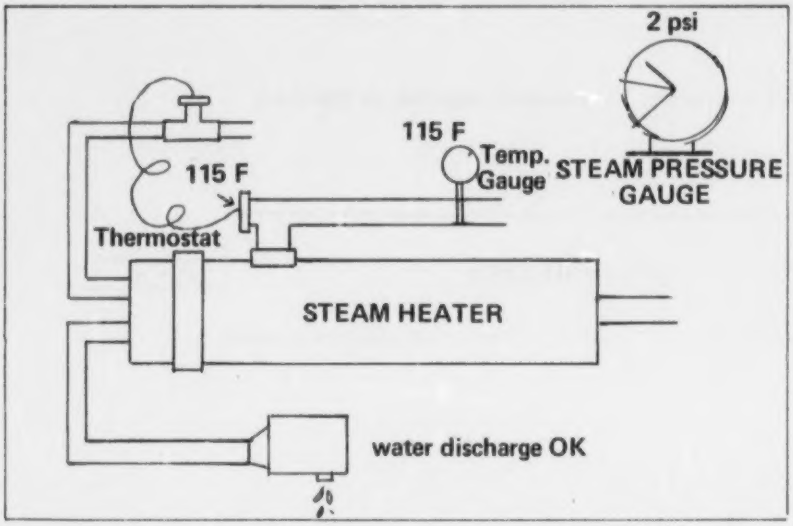

4. ____________________
2. ____________________
oil
STEAM HEATER
1 2 3 4 5
1. ____________________
3. ____________________

Check your answers.

1. Steam pressure in boiler
2. Thermostat
3. Steam Trap
4. Steam Regulator

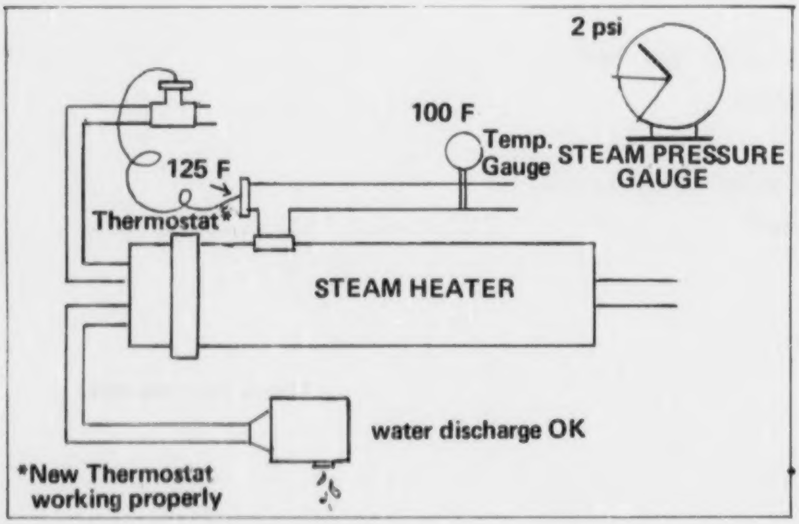
Below are two Steam Heaters with cold oil problems. WRITE WHAT SEEMS TO BE THE PROBLEM BESIDE EACH.

Suppose that: Normal operating temperature for the steam heater is 125 F and the oil temperature gauge is working.



2 psi
115 F
Temp. Gauge
STEAM PRESSURE GAUGE
115 F
Thermostat
STEAM HEATER
water discharge OK

1. PROBLEM: ____________________



2 psi
100 F
Temp. Gauge
STEAM PRESSURE GAUGE
125 F
Thermostat*
STEAM HEATER
water discharge OK
*New Thermostat working properly

2. PROBLEM: ____________________

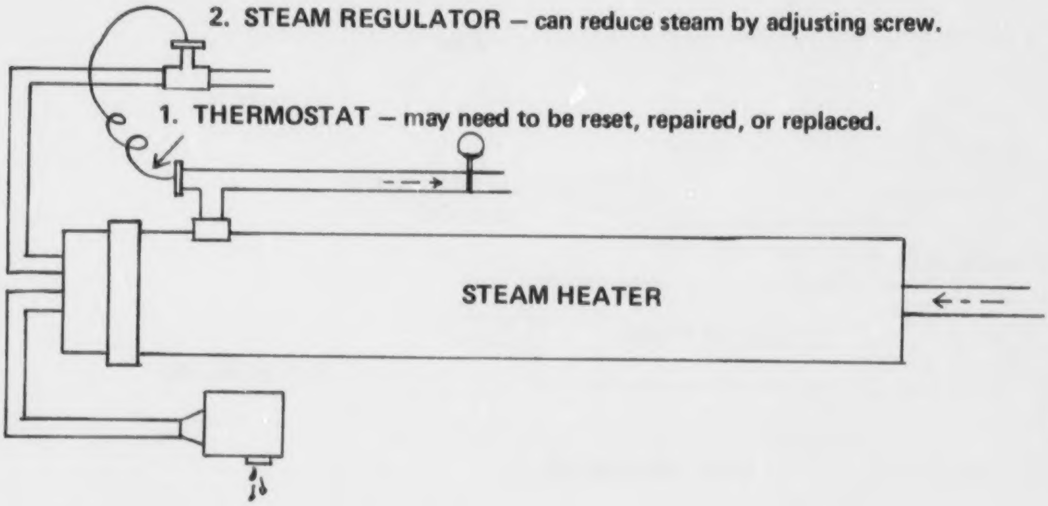
– Check your answers.

1. Reset thermostat to 125 F
2. Steam Regulator may need repair or replacement

---

7. STEAM HEATER - OIL TOO HOT

CHECK THESE TWO THINGS to solve a hot oil problem.


2. **STEAM REGULATOR** – can reduce steam by adjusting screw.

1. **THERMOSTAT** – may need to be reset, repaired, or replaced.

If these two steps don't solve the problem, call service.

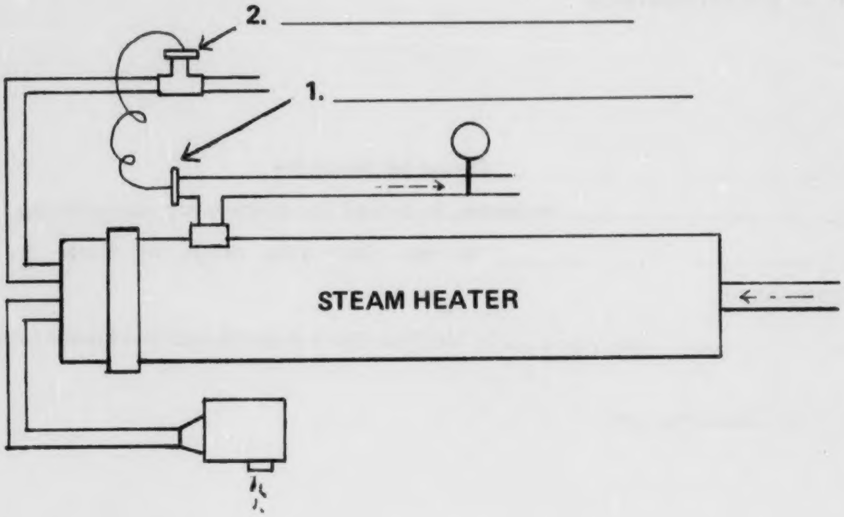
1. What do you always check when you have a temperature problem with a heater? ____________________

2. Too hot may mean too much steam. Where do you check steam going into the heater? ____________________

– Check your answers.

1. **Thermostat**
2. **Steam Regulator**

There are two checks to make if you get HOT OIL in the STEAM HEATER. LABEL THEM on the diagram below.



Check your diagram with that on the Preceding page.

STEAM HEATER REVIEW

Listed below are the COLD and HOT OIL TROUBLESHOOTING STEPS for the STEAM HEATER – COMPLETE THEM.

COLD OIL – STEAM HEATER

CHECK:

1. ______________ ____________ Gauge on the boiler.
2. ________________________ on heater. It should be set correctly and working.
3. ______________ ____________ to see that only drops of water are discharging periodically.
4. ______________ ____________ to see that steam is going into the heater properly.

HOT OIL – STEAM HEATER

CHECK:

1. ________________________ should be set correctly and working.
2. ________________________ should be admitting steam properly.

– Check your answers.

Answers to Steam Heater Review

COLD OIL:

1. Steam Pressure Gauge on boiler
2. Thermostat on Heater
3. Steam Trap — drops of water periodically
4. Steam Regulator — steam into heater

HOT OIL:

1. Thermostat
2. Steam Regulator

HANDBOOK SUMMARY

TURN TO PAGE 55 ,YOUR BOILER HANDBOOK.

Write STEAM HEATER at the top of the last column on the table if you have one. In this column, WRITE THE COLD AND HOT OIL TROUBLESHOOTING CHECKS just covered.

This completes the basic cold/hot oil checks to make before calling service.

Use BOILER HANDBOOK PAGES 54 — 55 for reference if you get an oil temperature problem.

SUMMARY

These questions review the important things in this section:

1. **What is the biggest cause of a smoking boiler?** ____________________
2. **If you get smoke, what is the first thing to check?** ____________________
3. **What gauge right after a heater tells you if there is an oil temperature problem there?** ____________________
4. **Is the proper atomizing temperature determined by the oil you use or the burner you have?** ____________________
5. **What is one of the first things you always check on any heater when there is an oil temperature problem?** ____________________
6. **If you have an open circuit or blown fuse, what will be the temperature problem in the electric heater?** ____________________
7. **What heater has to be actually turned on in order to heat the oil?** ____________________
8. **What electric heater setting should match the oil atomizing temperature?** ____________________
9. **What instruments will tell you if the heating element in the electric heater is working?** ____________________
10. **What points inside the electric heater thermostat should be checked if you get hot oil there?** ____________________
11. **If the atomizing temperature is 150 F and your electric heater thermostat is set at 160 F, what would you do?** ____________________

12. What should be checked in the case of cold oil in the hot water oil heater to be sure the heater is getting hot water to heat the oil? ____________________

13. What is the one check you make on the hot water oil heater whether the oil is too hot or too cold? ____________________

14. What do you need in the boiler in order to get steam in the steam heater? ____________________

15. What instrument measures how much steam is in the boiler? ____________________

16. Through what is condensate (drops of water) discharged from the steam heater? ____________________

17. What instrument is connected to the thermostat and regulates steam going into the steam heater? ____________________

18. If the oil is too hot in the steam heater, what two instruments should be checked? ____________________

____

19. If all troubleshooting checks are made and an incorrect oil temperature problem is not solved, what should be done? ____________________

– Check your answers.

ANSWERS TO REVIEW QUESTIONS:

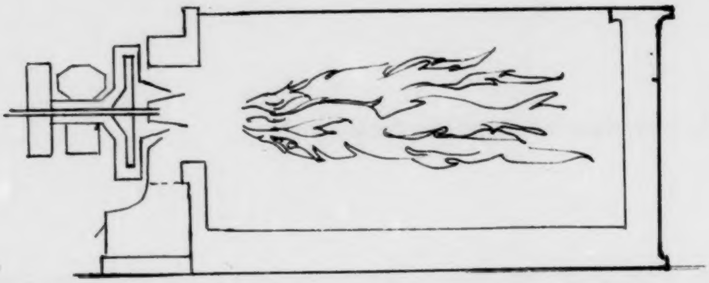
1. incorrect oil temperature
2. oil temperature
3. oil temperature gauge
4. oil
5. thermostat
6. cold oil
7. electric heater
8. thermostat
9. oil temperature gauges on each side of heater
10. warp points
11. reset thermostat to 150 F
12. pump
13. thermostat
14. steam pressure
15. steam pressure gauge
16. steam trap
17. steam regulator
18. thermostat
    steam regulator
19. call service

Section 4
TROUBLESHOOTING BOILERS; FLAME READING

1. FLAME AWAY FROM THE BURNER

Most boilers have a peephole. Through it you can see the flame.

Look at this flame.



CIRCLE THE CORRECT ANSWER:
This flame is: A. too close to the burner.
B. too far away from the burner.

B is correct. The most likely reason is that the flame above is being pushed off the burner by TOO MUCH PRIMARY AIR.

The PRIMARY AIR SHUTTER (regulated by LINKAGE) is taking in too much air. If you know how to set the Primary Air Shutter, adjust it carefully. The correct air/oil ratio is the key to good flames and smokeless burning. If you don't know a lot about it, call service.

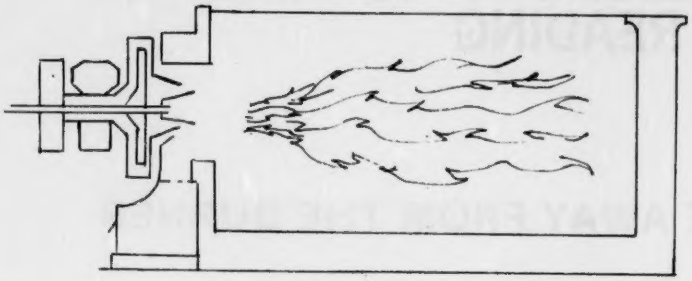
Check the parts below which may need adjustment to correct a flame off the burner:

_______ Primary Air Shutter
_______ Primary Air Linkage
_______ Secondary Air Damper

– Check your answers

√ **Primary Air Shutter**
√ **Primary Air Linkage**
____ **Secondary Air Damper**

LOOK AT THIS FLAME.



1. How does this flame not look right? ____________________

2. What should you suspect when you get a flame like this? ____________________

– Check your answers.

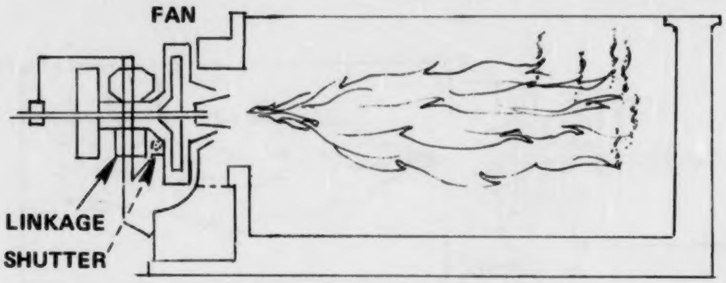
1. **too far away from burner**
2. **too much primary air**

---

2. SMOKY FLAME

A Smoky Flame (unstable and flickering) means NOT ENOUGH AIR. Check the three parts of the primary air system.

PRIMARY AIR



The PRIMARY AIR SHUTTER and LINKAGE can be lubricated and cleaned but change the setting only if you have been taught to do it accurately on your system.

You know how your FAN should sound. Blades may need to be cleaned; belts may need to be tightened.

CIRCLE THE PARTS ON THE DIAGRAM THAT YOU CAN KEEP CLEAN AND IN GOOD WORKING ORDER.

Answer these questions:

1. **Do smoky flames come from too much or too little air?** ____________________
2. **When you get a smoky flame, first check the** ____________________ **air.**

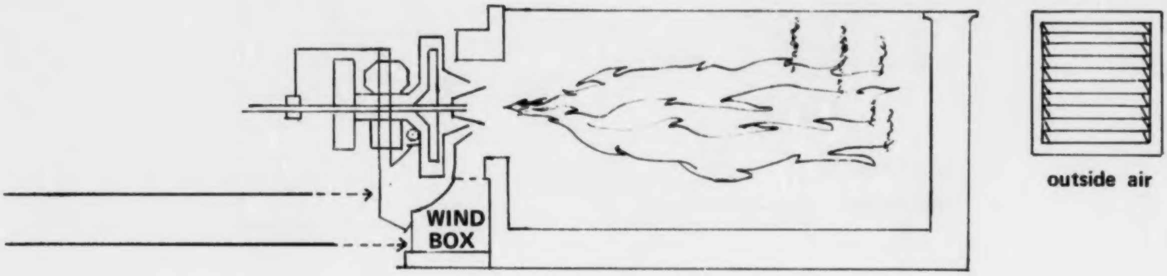
– Check your answers.

1. too little
2. primary

If the Primary Air is all right, check –

SECONDARY AIR

The Windbox may not be delivering enough air. LABEL THE LINKAGE and DAMPER on the lines in the diagram.



Linkage must be set properly and lubricated to move easily. It should clear the floor when in the lowest position.

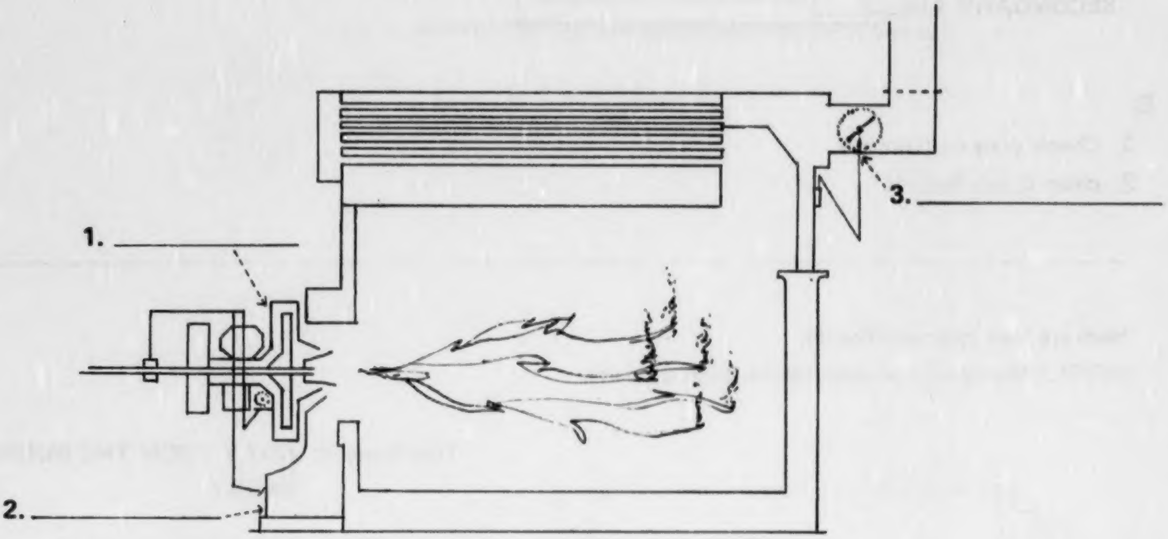
The damper should be clean.

1. **If you get a smoky flame, what do you check after the primary air?** ______________________
2. **What equipment must be set and move easily to deliver secondary air?** ______________________ ______________________

– Check your answers.

1. **Secondary Air**
2. **Linkage, Damper**

SMOKY FLAME - NOT ENOUGH AIR



A.

On the diagram, LABEL THREE SOURCES OF AIR to check when you get a Smoky Flame –

PRIMARY AIR
SECONDARY AIR
STACK DAMPER

B.

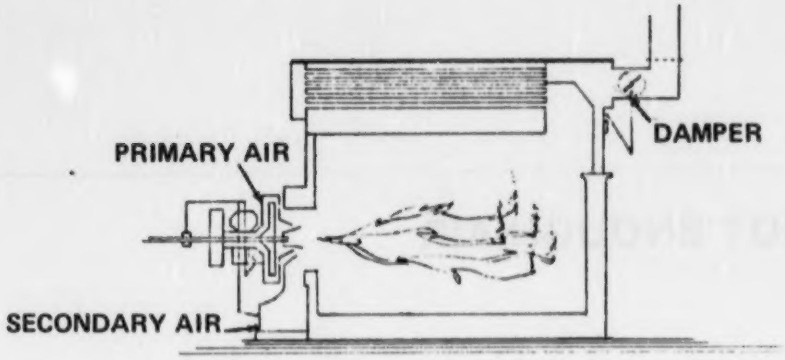
The STACK DAMPER should move freely and not be blocked. You may or may not adjust this damper, but you can keep it lubricated and clean.

1. **Is your stack damper manual or automatic?** ____________________

2. **What can you do to keep the stack damper in good condition?** ____________________

– Check your answers.

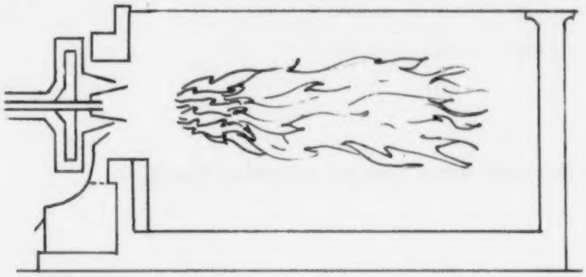
A.



B.

1. Check your own answer
2. clean it, lubricate it

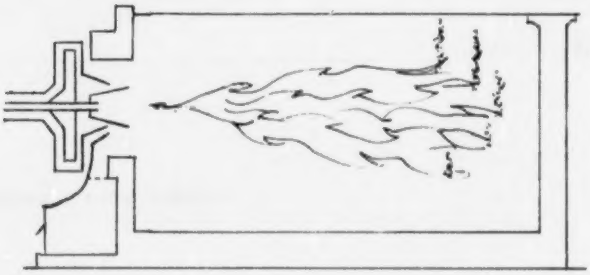
Here are two incorrect flames.
CIRCLE the correct answers beside each diagram.



This flame is: AWAY FROM THE BURNER
SMOKY

A cause is: TOO MUCH AIR
NOT ENOUGH AIR

Troubleshooting
Checks: PRIMARY AIR
SECONDARY AIR
STACK DAMPER



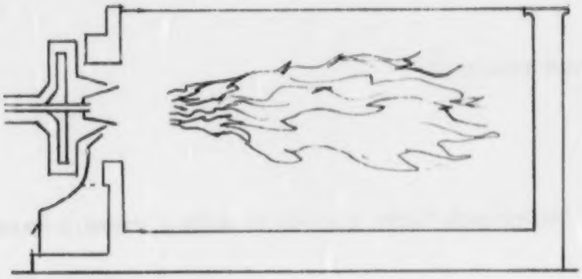
This flame is: AWAY FROM THE BURNER
SMOKY

A cause is: TOO MUCH AIR
NOT ENOUGH AIR

Troubleshooting
Checks: PRIMARY AIR
SECONDARY AIR
STACK DAMPER

– Check your answers.

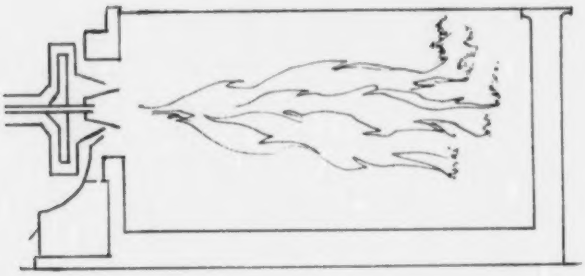
ANSWERS TO PREVIOUS PAGE.



This flame is: AWAY FROM THE BURNER

A cause is: TOO MUCH AIR

Troubleshooting
Checks: PRIMARY AIR



This flame is: SMOKY

A cause is: NOT ENOUGH AIR

Troubleshooting
Checks: PRIMARY AIR
SECONDARY AIR
STACK DAMPER

HANDBOOK SUMMARY

TURN TO PAGE 56.
Here is an incorrect flame summary for your future reference.

NOW, LOOK AT PAGE 57 in the HANDBOOK.

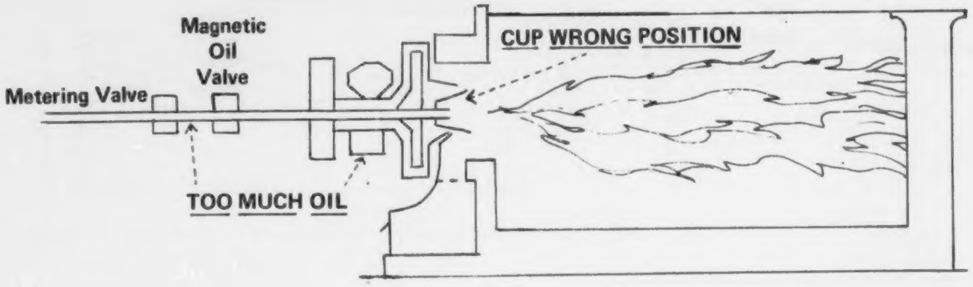
Here is your own table of incorrect oil flames. Under each flame is space to write a probable cause of the flame, and some Troubleshooting Checks.

WRITE IN A CAUSE AND TROUBLESHOOTING CHECKS UNDER "FLAME AWAY FROM THE BURNER" AND "SMOKY FLAME." Use Page 127 in this book for reference.

After completing this work, go on to the next page.

3. FLAME TOO LONG

HITS THE WALL – SMOKY TIPS


Magnetic Oil Valve
Metering Valve
CUP WRONG POSITION
TOO MUCH OIL

If there is TOO MUCH OIL going into the burner, there will be too much flame (too long) in the firebox.

Your upgraded system should have the OIL VALVES shown above. The Metering Valve is set by the oil representative; you should change it only if you have been trained on your system.

ANSWER THESE QUESTIONS:

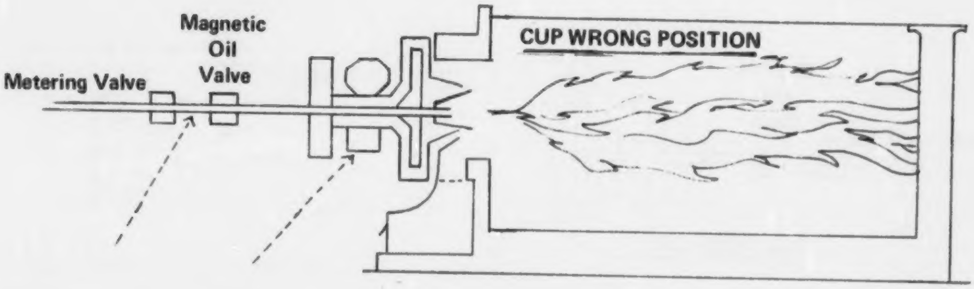
1. Too much oil may give you what kind of flame? ______________________________

2. On the diagram, two __________ regulate the oil flow.

– Check your answers.

1. too long
2. valves

WRITE ONE CAUSE OF A LONG FLAME on the line in the diagram:


Magnetic Oil Valve
Metering Valve
CUP WRONG POSITION

____

Check your answer on the preceding page.

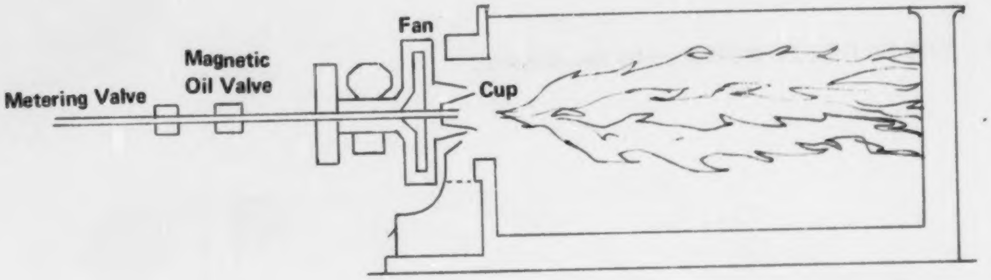
If the CUP is set OUT FROM THE BURNER too far, it will extend the flame and cause it to hit the wall. REPLACE THE CUP CORRECTLY EACH TIME YOU CLEAN IT.

ANSWER THESE QUESTIONS:

1. In addition to oil valves what device shown on the diagram must be set correctly for a good flame? ____________________
2. Are you responsible for correct cup position? ____________________

– Check your answers.

1. cup
2. yes


Fan
Magnetic Oil Valve
Metering Valve
Cup

When your smoke alarm goes off, you may see a flame like the one above in your firebox.

1. What is wrong with the flame above? ____________________

2. What are two causes of this incorrect flame? ____________________
____

3. What instruments may be adjusted to correct it? ____________________
____

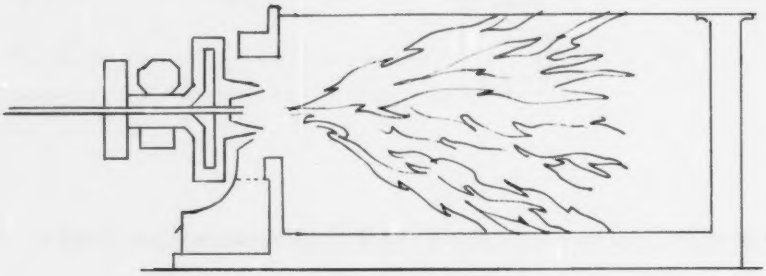
– Check your answers.

1. too long
2. too much oil, wrong cup position
3. oil valves, cup

---

4. ANOTHER BAD FLAME

CIRCLE THE CORRECT WORD under the diagram:



Flame is too
NARROW/WIDE

The flame may become too wide like the one above if the AIR CONE AROUND THE CUP is NOT STRONG ENOUGH. Or, the CUP could be in the WRONG POSITION.

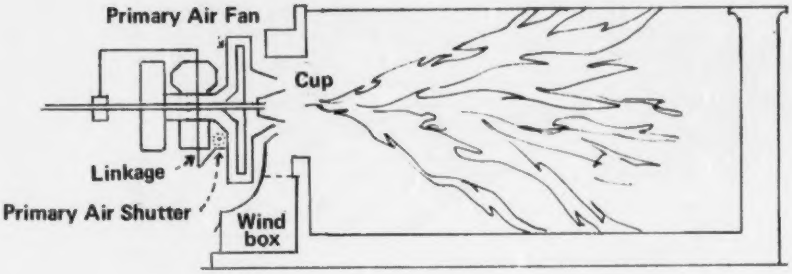
ANSWER THESE QUESTIONS:

1. You may get a wide flame if there is not enough:
   A. PRIMARY AIR
   B. SECONDARY AIR ______________________

2. What must be in the proper position to atomize a good flame? ______________________

— Check your answers.

1. A. Primary Air
2. cup


Primary Air Fan
Cup
Linkage
Primary Air Shutter
Wind box

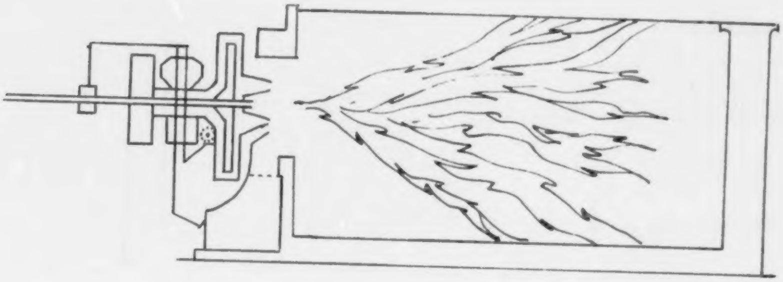
Two causes of a WIDE FLAME have been considered.

1. What equipment would you check to troubleshoot TOO LITTLE PRIMARY AIR? (see diagram) __________ __________ __________

2. If the Primary Air is OK, what other equipment would you check to troubleshoot a wide flame? __________

– Check your answers.

1. Primary Air Shutter
   Linkage
   Primary Air Fan
2. cup



When your smoke alarm goes off you may see a flame like the one above.

1. How is the flame above incorrect? ______________________

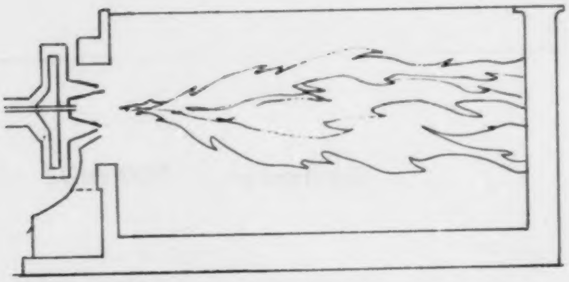
2. What are two common causes of this type of flame? ______________________
   ____

3. What equipment would you check to correct it? ______________________
   ____

– Check your answers.

1. **too wide**
2. **not enough Primary Air**
   cup in wrong position
3. **Primary Air Shutter, Linkage, Fan, Cup**

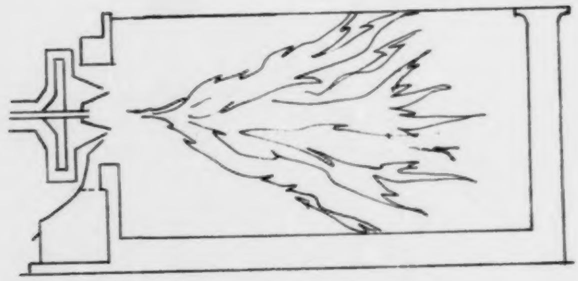
Below are two incorrect flames.
CIRCLE the correct answers beside each diagram.



This flame is: **TOO LONG**
TOO WIDE

Some causes are: **TOO MUCH OIL**
TOO LITTLE PRIMARY AIR
CUP IN WRONG POSITION

Troubleshooting Checks: **PRIMARY AIR**
OIL VALVES
CUP



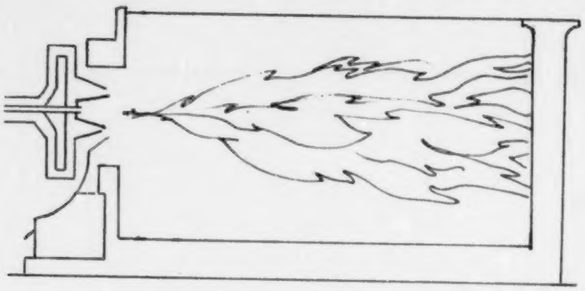
This flame is: **TOO LONG**
TOO WIDE

Some causes are: **TOO MUCH OIL**
TOO LITTLE PRIMARY AIR
CUP IN WRONG POSITION

Troubleshooting Checks: **PRIMARY AIR**
OIL VALVES
CUP

– Check your answers.

ANSWERS TO PREVIOUS PAGE:



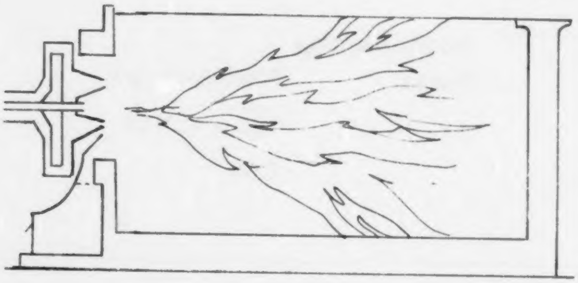
This flame is: TOO LONG

Some causes are: TOO MUCH OIL

CUP IN WRONG POSITION

Troubleshooting Checks: OIL VALVES

CUP



This flame is: TOO WIDE

Some causes are: TOO LITTLE PRIMARY AIR

CUP IN WRONG POSITION

Troubleshooting Checks: PRIMARY AIR

CUP

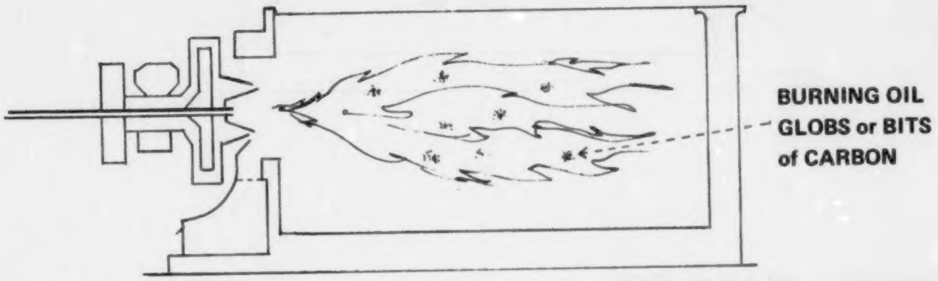
HANDBOOK SUMMARY

TURN TO YOUR BOILER HANDBOOK, PAGE 57.

COMPLETE INCORRECT FLAME COLUMNS 3 and 4 with the information you have just learned. Use this page for reference.

5. "SPARKY" FLAME

Here are small areas where too much oil is burning and bits of burning carbon can be seen. They do not look like electric sparks but are spots where extra oil or carbon is burning.



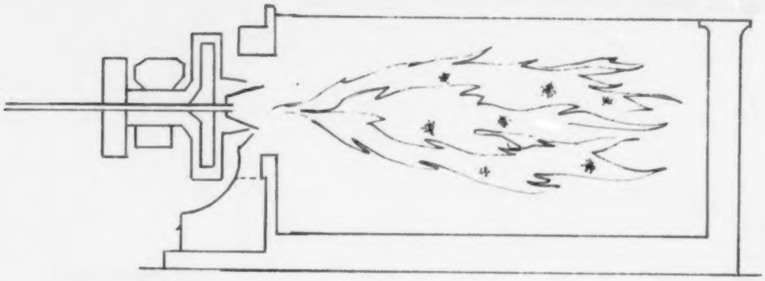
When this happens the CUP may be either DIRTY, DAMAGED, or in the INCORRECT POSITION. If cleaning and adjusting the cup doesn't help, call service.

1. "Sparks" in the flame could be bits of burning __________ or ____________________

2. What can you do to try to correct a "sparky" flame? ____________________
____

– Check your answers.

1. oil or carbon
2. clean and adjust the cup



1. Why is the flame above not a good flame? ____________________

2. What could be causing this flame? ____________________

3. What do you check to troubleshoot this flame? ____________________

– Check your answers.

1. has "sparks" in it
2. oil globs or carbon
3. cup (clean or adjust)

---

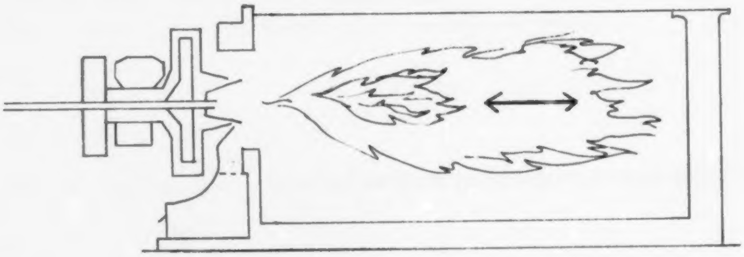
6. PULSATING FLAME

A pulsating flame is one that changes in rhythm - large, small, large, small, etc. It is likely to be noisy.

Three possible causes you may be able to correct:

WRONG AMOUNT OF OIL
UNEVEN OIL FLOW
NOT ENOUGH AIR

CIRCLE the correct words under the picture.



To troubleshoot this flame, check the
AIR/OIL/CUP

As there are many causes of a pulsating flame, it is difficult to troubleshoot. If the air and oil checks you will learn don't stop pulsation, call service.

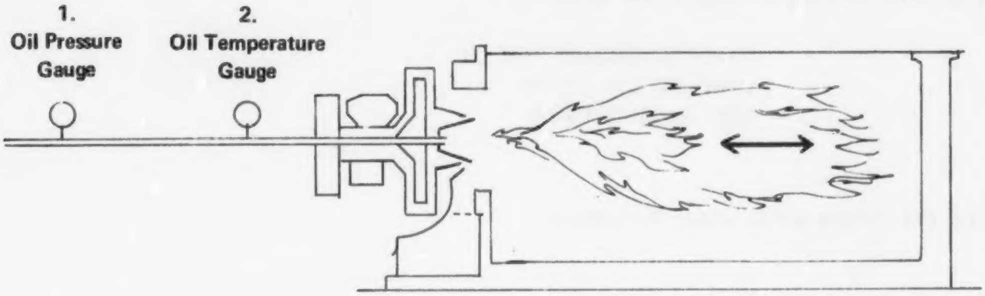
What are two oil problems which may cause a pulsating flame? ____________________

____

— Check your answers.

wrong amount of oil
uneven oil flow

Two checks concerning oil:



What should the oil temperature closest to the burner be on your system? ______________________

What should your oil pressure gauge read? ______________________

You have this information in your Handbook. Checking OIL TEMPERATURE and troubleshooting OIL HEATERS was covered in the last section.

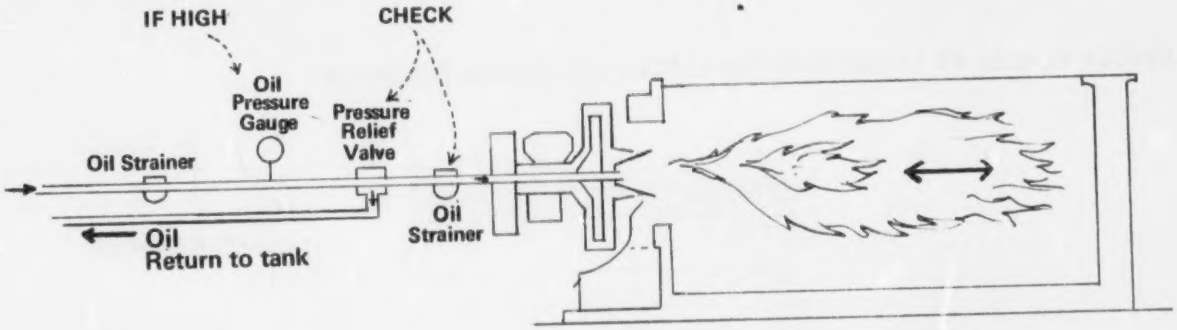
OIL PRESSURE checks will be taken up on the next page.

1. **What is wrong with the flame above?** ______________________
2. **What two oil gauges do you check in troubleshooting it?** ______________________

– Check your answers.

1. **Pulsating flame**
2. **Oil Temperature Gauge**
   Oil Pressure Gauge

If OIL PRESSURE is the problem, it will be TOO HIGH.


IF HIGH
CHECK
Oil Pressure Gauge
Pressure Relief Valve
Oil Strainer
Oil Strainer
Oil
Return to tank

ON THE DIAGRAM:

CIRCLE THE PART that sends excess oil back to the tank.

PUT CHECKS (✓) ON THE PARTS that clean the oil but could become dirty and clogged.

If the **PRESSURE RELIEF VALVE** doesn't send enough oil back to the tank, it should be adjusted by service. A clogged line, perhaps at the **STRAINERS**, will send the oil pressure up.

1. Where does the Pressure Relief Valve send excess oil? ____________________

2. Which of these can you probably take care of without calling service? ____________________

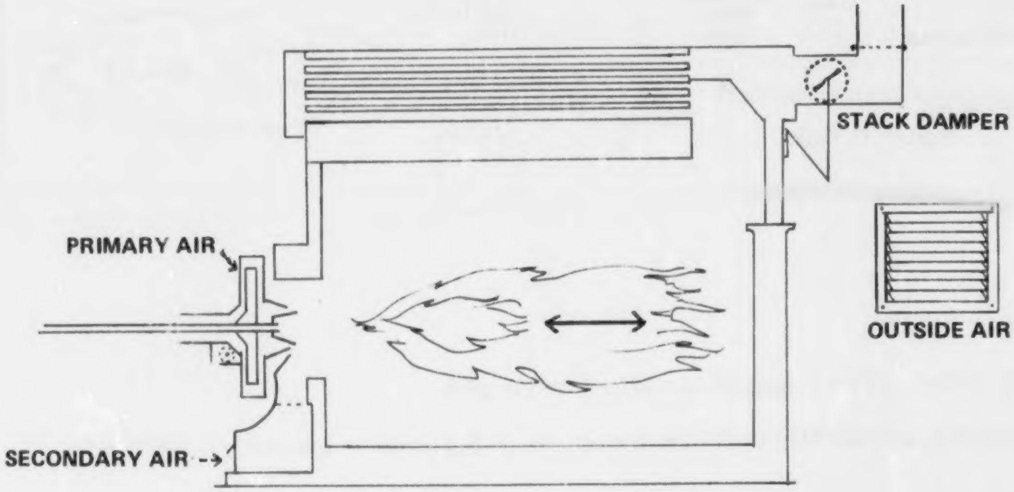
3. If you get high oil pressure, what two things should you check? ____________________
   ____

– Check your answers.

1. to the tank
2. oil strainers
3. pressure relief valve
   oil strainers

After checking the OIL TEMPERATURE and OIL PRESSURE, CHECK for TOO LITTLE AIR before calling service.

CIRCLE PLACES TO CHECK FOR TOO LITTLE AIR ON THE DIAGRAM:



To check for too little air, look at all four air sources above.

1. How is the flame above not a good one? ____________________

2. What are the areas to check? (CHECK THREE BELOW)

   ________ Oil Temperature
   ________ Cup Condition
   ________ Oil Pressure
   ________ Too Much Air
   ________ Too Little Air

3. How many air sources are there to check if you get a flame like the one above? ____________________

– Check your answers

1. Pulsating **3. Four**

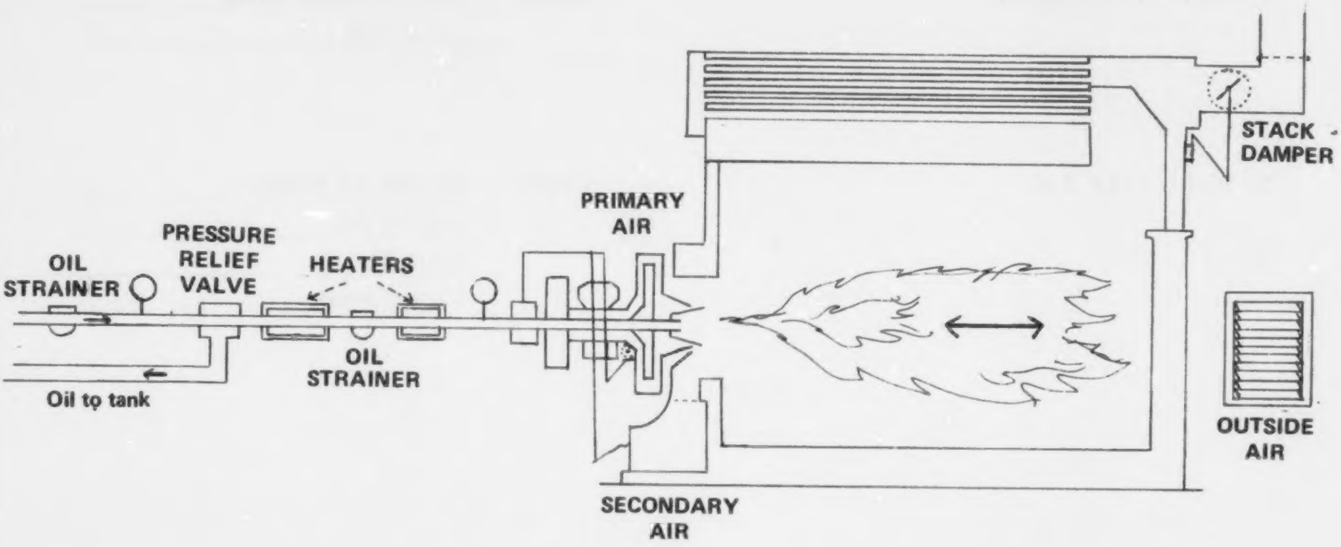
2. ✓ Oil Temperature

__ Cup Condition

✓ Oil Pressure

__ Too Much Air

✓ Too Little Air


OIL STRAINER
PRESSURE RELIEF VALVE
HEATERS
OIL STRAINER
Oil to tank
PRIMARY AIR
SECONDARY AIR
STACK DAMPER
OUTSIDE AIR

FOR EACH MAJOR AREA BELOW, WRITE THE PARTS FROM THE DIAGRAM THAT YOU SHOULD CHECK BEFORE CALLING SERVICE.

PULSATING FLAME CHECKS:

1. OIL TEMPERATURE INCORRECT **Check:** ____________________

2. HIGH OIL PRESSURE **Check:** ____________________

____

3. TOO LITTLE AIR **Check:** ____________________

____

____

____

– Check your answers.

ANSWERS TO PULSATING FLAME CHECKS:

1. OIL TEMPERATURE INCORRECT

Check: Heaters

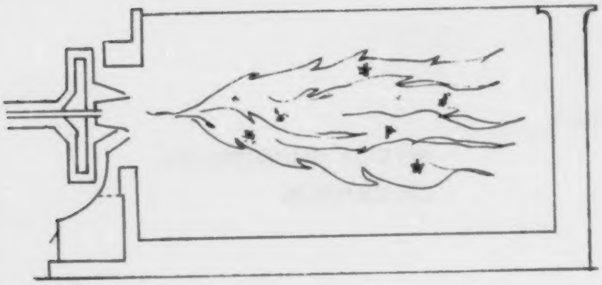
2. HIGH OIL PRESSURE

Check: Pressure Relief Valve
Oil Strainers

3. TOO LITTLE AIR

Check: Outside Air Supply
Primary Air
Secondary Air
Stack Damper

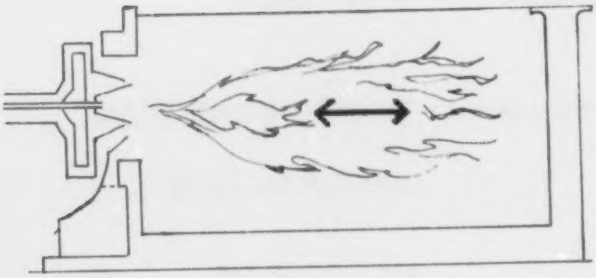
Below are the last two incorrect flames presented. CIRCLE the CORRECT ANSWERS for each.



This flame is:
"SPARKY"
PULSATING

A cause is:
WRONG AMOUNT OF OIL
BITS OF BURNING OIL OR CARBON
UNEVEN OIL FLOW
TOO LITTLE AIR

Troubleshooting Checks:
CUP
OIL TEMPERATURE GAUGE
OIL PRESSURE GAUGE
AIR SUPPLY



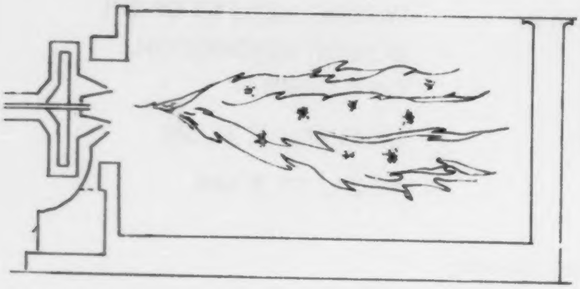
This flame is:
"SPARKY"
PULSATING

Some causes are:
WRONG AMOUNT OF OIL
BITS OF BURNING DIRT OR OIL
UNEVEN OIL FLOW
TOO LITTLE AIR

Troubleshooting Checks:
CUP
OIL TEMPERATURE GAUGE
OIL PRESSURE GAUGE
AIR SUPPLY

– Check your answers.

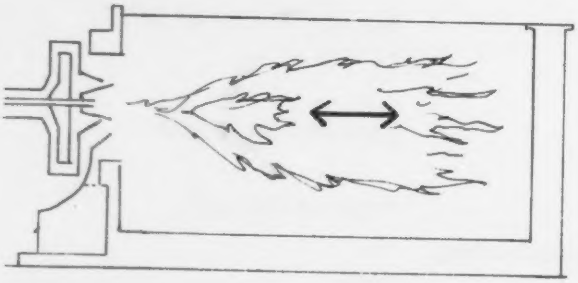
ANSWERS TO PREVIOUS PAGE:



This flame is: "SPARKY"

A cause is: BITS OF BURNING OIL OR CARBON

Troubleshooting Checks: CUP



This flame is: PULSATING

Some causes are:

WRONG AMOUNT OF OIL

UNEVEN OIL FLOW

TOO LITTLE AIR

Troubleshooting Checks:

OIL TEMPERATURE GAUGE
OIL PRESSURE GAUGE
AIR SUPPLY

HANDBOOK SUMMARY

TURN TO PAGE 57.

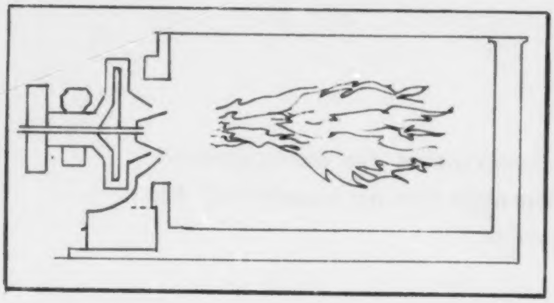
COMPLETE THE LAST TWO INCORRECT FLAME COLUMNS with the information you have just learned. Use page 146 in this book for reference.

This completes some basic flame checks should your smoke alarm go off. If a problem occurs which these pages have not covered or if the problem is not easily solved, call service.

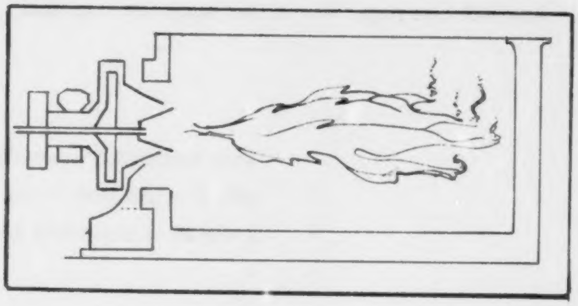
REVIEW QUESTIONS

1. When the smoke alarm goes off, what is the key to troubleshooting after checking the oil temperature? ______________________

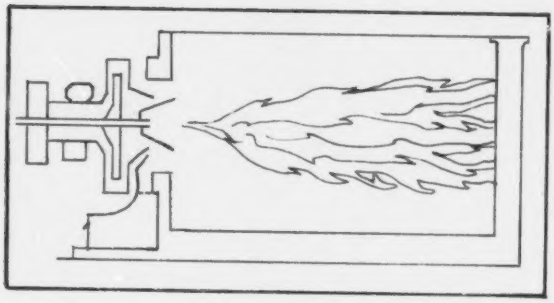
Under each, write what is incorrect about the flames below:



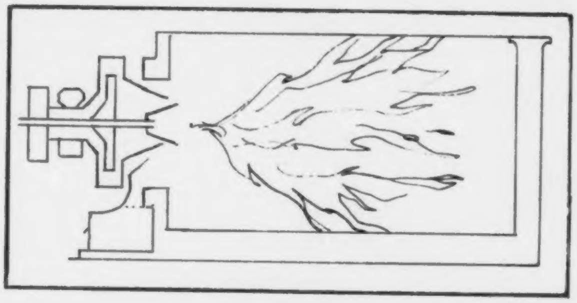
2. ______________________



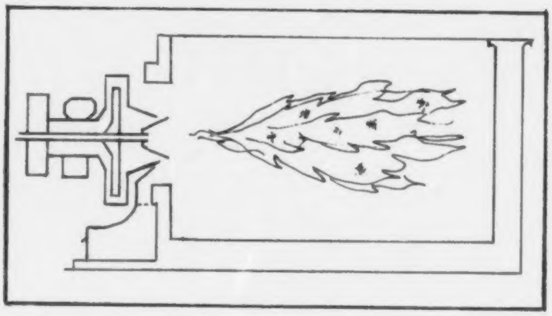
3. ______________________



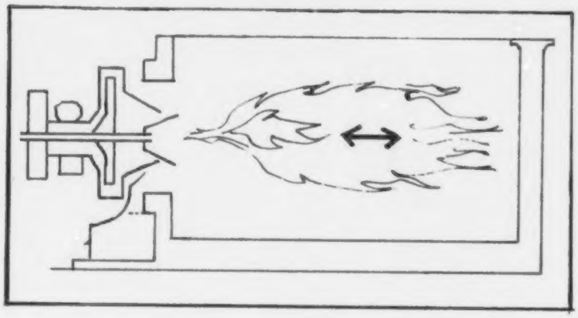
4. ______________________



5. ______________________



6. ______________________



7. ______________________

8. If the flame is pushed away from the burner, the cause is often too much ___________ air. ___________________________

9. Even though you may not make adjustments, what can you do to shutters and linkage to keep them working well? ___________________________

10. What are three main areas (other than outside air) to check when you get a smoky flame and there is not enough air? ___________________________
____
____

11. A flame that is too long or too wide could be the result of an incorrect ___________ position. ___________________________

12. Is it too much or too little primary air that can cause a flame to be too wide? ___________________________

13. What could be in the oil that may cause "sparks" in the flame? ___________________________

14. What burning supply often needs adjustment to correct a pulsating flame? ___________________________

15. What two gauges should you first check when you get a pulsating flame? ___________________________
____

16. Assuming normal oil flow, what basic supply usually needs adjustment when you get smoke? ___________________________

17. If oil temperature adjustment and flame reading don't enable you to solve a smoke problem, what should you do? ___________________________

— Check your answers.

ANSWERS TO REVIEW QUESTIONS:

1. the flame
2. flame away from the burner
3. smoky flame
4. too long
5. too wide
6. "sparky" flame
7. pulsating flame
8. primary
9. clean and/or lubricate
10. primary air
    secondary air
    stack damper
11. cup
12. too little
13. oil globs or carbon bits
14. oil
15. oil temperature gauge
    oil pressure gauge
16. air
17. call service

Part 2

THE PROPER OPERATION AND MAINTENANCE OF FLUE FED INCINERATORS

Section 5
INCINERATORS;
BASIC PARTS AND FUNDAMENTALS

1. INCINERATORS

In the past, incinerators have belched out smoke and fly ash. To combat this health and property hazard, New York City has passed upgrading laws. These include:

I. INCINERATORS UPGRADED – INCLUDING SCRUBBERS
II. OPERATORS TRAINED IN RUNNING UPGRADED EQUIPMENT

Some smoke and fly ash are unavoidable. Keep emissions at a minimum by keeping your INCINERATOR CLEAN and in GOOD CONDITION.

CHECK (√) what you can do to keep down incinerator pollution:

____1. Take this course in proper incinerator operation.
____2. Keep the incinerator clean and in good condition.

– Check your answer.

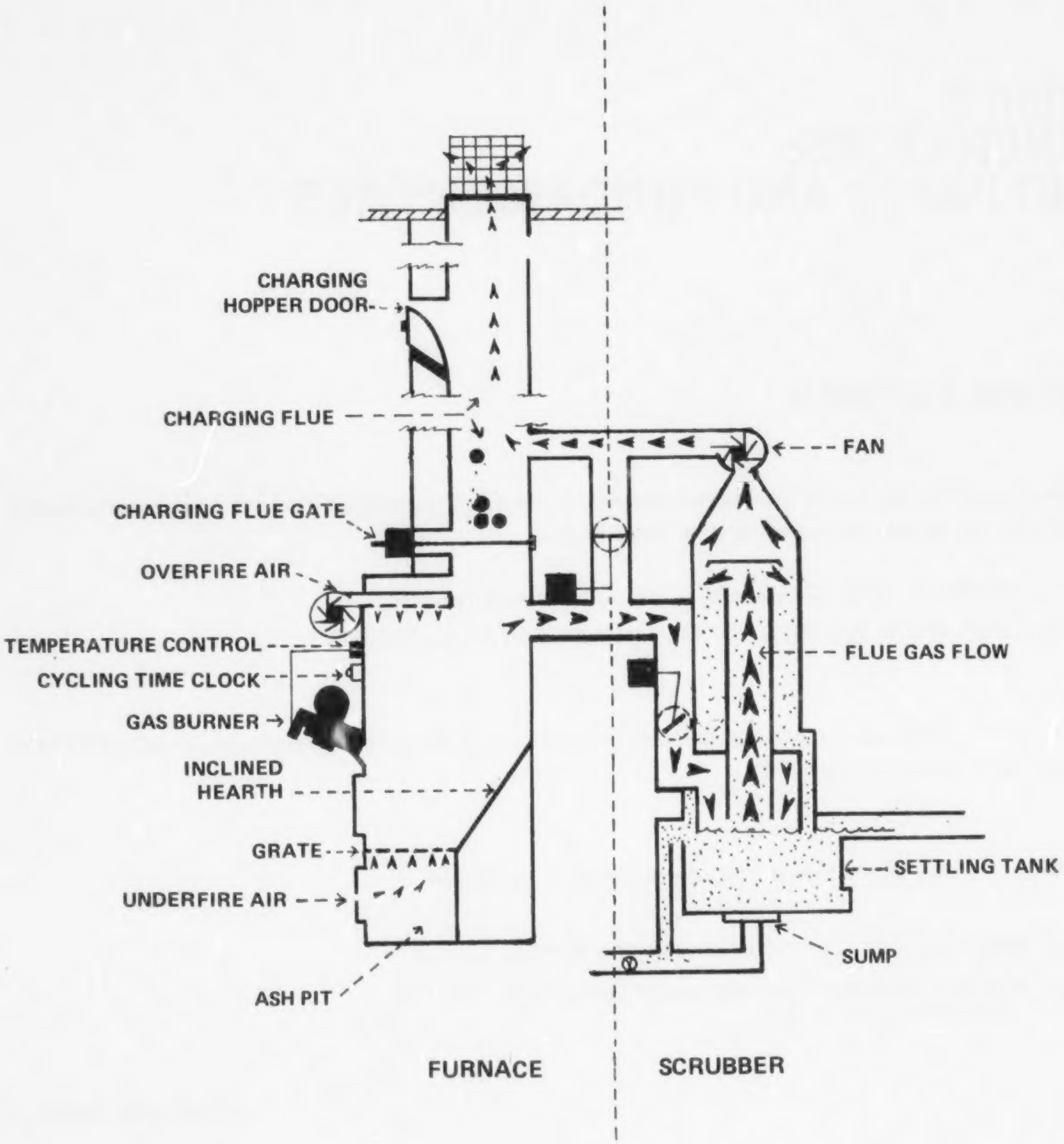
Preceding page blank

√ 1.
√ 2.

---

2. INCINERATOR PARTS

HERE ARE SOME BASIC INCINERATOR PARTS. LOOK THEM OVER.


CHARGING HOPPER DOOR
CHARGING FLUE
CHARGING FLUE GATE
OVERFIRE AIR
TEMPERATURE CONTROL
CYCLING TIME CLOCK
GAS BURNER
INCLINED HEARTH
GRATE
UNDERFIRE AIR
ASH PIT
FAN
FLUE GAS FLOW
SETTLING TANK
SUMP
FURNACE
SCRUBBER

Answer these questions using the opposite diagram:

1. **As the garbage is put through the hopper door and falls down the charging flue, what device holds it until firing time?** ____________________

2. **Name the two air supplies to the incinerator.** ____________________

3. **What timing device controls the incinerator?** ____________________

4. **How hot the fire is, is regulated by what control?** ____________________

5. **What kind of a burner provides the required incinerator temperature?** ____________________

6. **What major part cleans the incinerator gases by circulating them through water?** ____________________

7. **What is at the bottom of the scrubber which lets you drain or clean the settling tank?** ____________________

– Check your answers.

1. Charging flue gate
2. Overfire air
   Underfire air
3. Cycling time clock
4. Temperature Control
5. Gas Burner
6. Scrubber
7. Scrubber sump

---

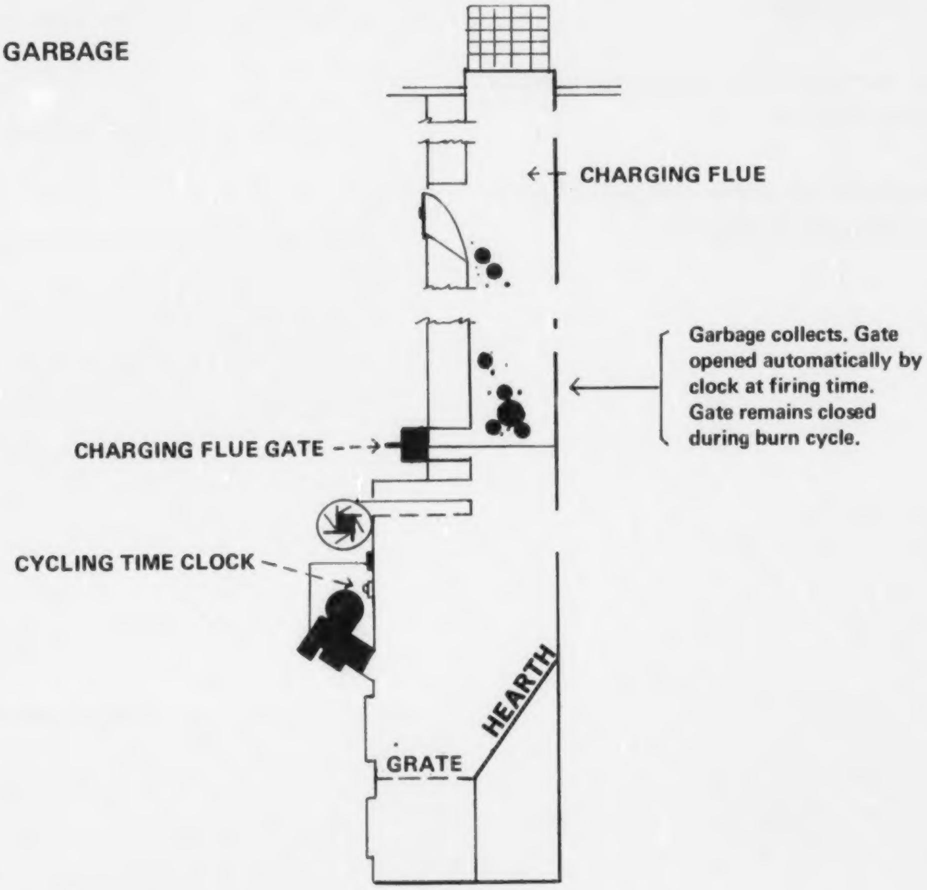
3. BURNING

A burn needs three things:

1. GARBAGE
2. AIR
3. IGNITION AND HEAT - the burner

Good combustion needs a FAST, HOT FIRE. For this to happen the garbage, air, draft, and burner must be controlled. The CYCLING TIME CLOCK is set and at the proper time these three are automatically brought together for burning.

FIRST – GARBAGE

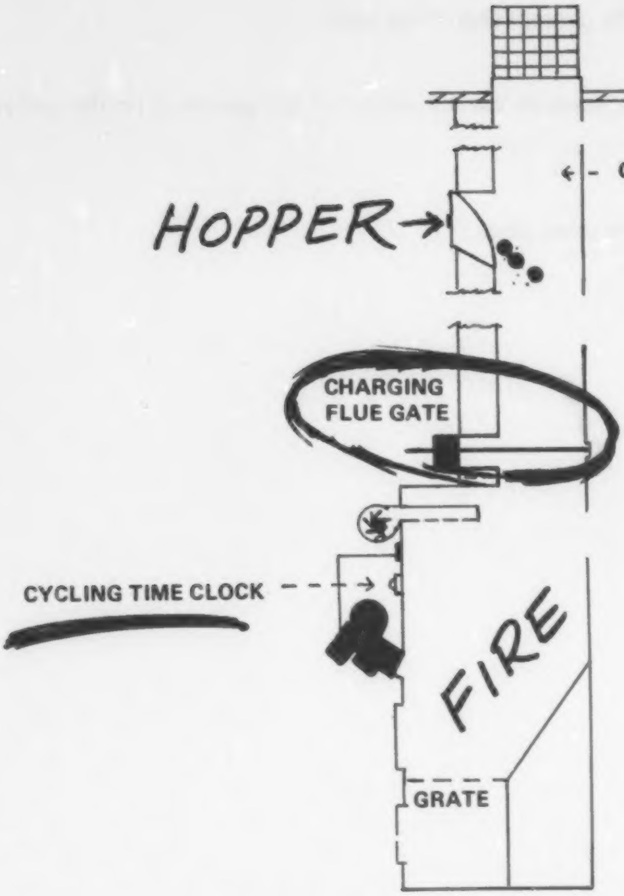

CHARGING FLUE
Garbage collects. Gate opened automatically by clock at firing time. Gate remains closed during burn cycle.
CHARGING FLUE GATE
CYCLING TIME CLOCK
HEARTH
GRATE

MAKE THE FOLLOWING MARKS ON THE DIAGRAM:

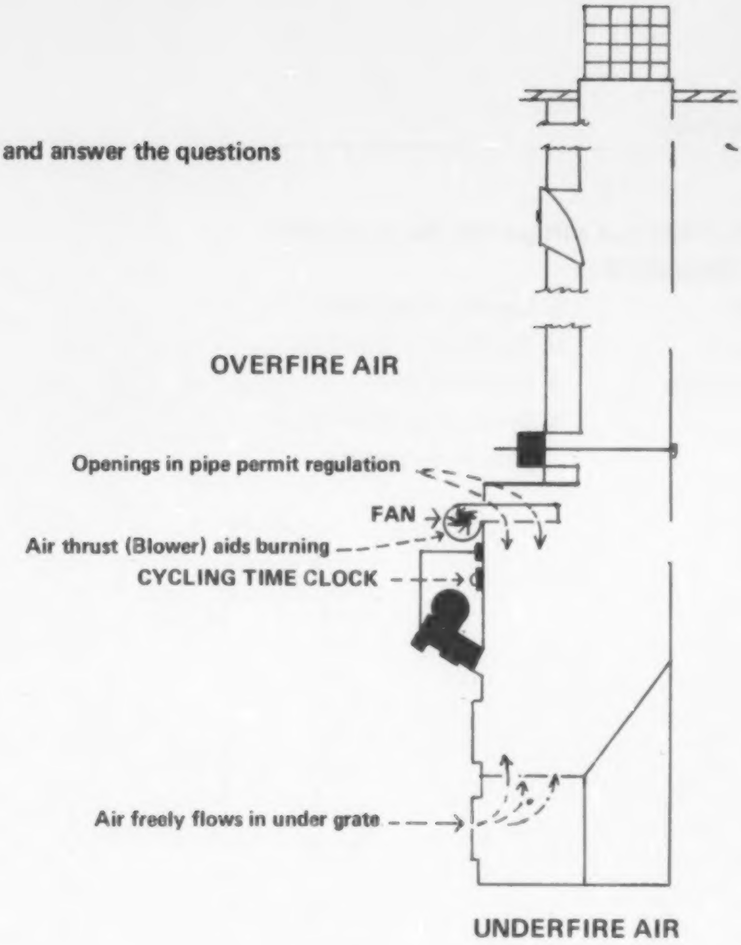
- WRITE "HOPPER" where the tenants deposit their garbage.
- PUT A CIRCLE around the part that holds the garbage until firing time.
- UNDERLINE THE NAME of the part that controls the movement of the gate to drop the garbage onto the hearth.
- WRITE "FIRE" in the chamber where the fire takes place.

– Check your answers.

ANSWERS TO PREVIOUS PAGE:


CHARGING FLUE
HOPPER
CHARGING FLUE GATE
CYCLING TIME CLOCK
FIRE
GRATE

Study this diagram and answer the questions


OVERFIRE AIR
Openings in pipe permit regulation
FAN
Air thrust (Blower) aids burning
CYCLING TIME CLOCK
Air freely flows in under grate
UNDERFIRE AIR

Remember that the CYCLING TIME CLOCK regulates all major equipment.

1. Which is turned on and off by the time clock, Overfire Air or Underfire Air? ____________________

2. Which is produced by a fan and blown into the incinerator, Overfire Air or Underfire Air? ____________________

3. Which air to the incinerator is not turned on by the time clock, but is free flowing? ____________________

4. What device starts the fan for Overfire Air? ____________________

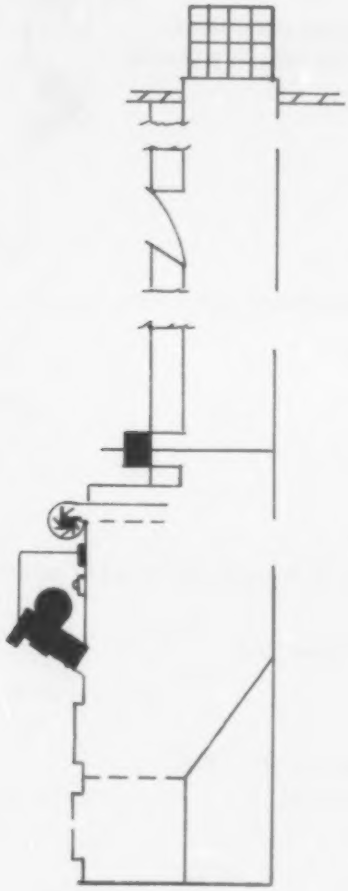
– Check your answers.

1. Overfire Air
2. Overfire Air
3. Underfire Air
4. Cycling Time Clock

This is how GARBAGE and AIR get into the incinerator.

LABEL THE DIAGRAM:

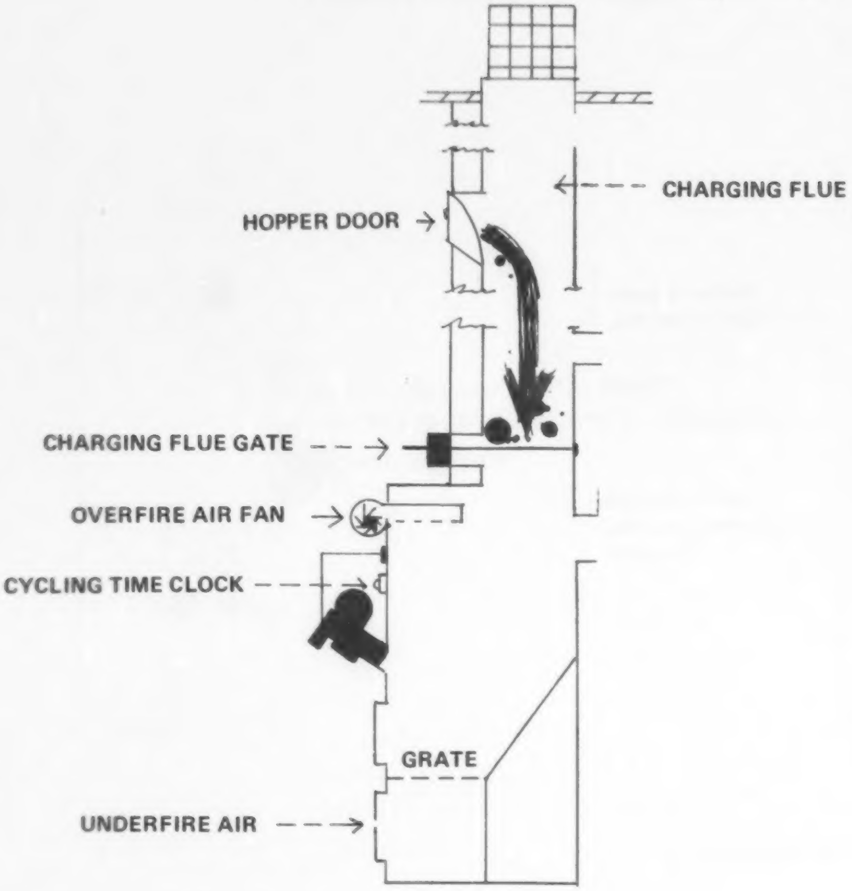
1. Hopper Door
2. Charging Flue
3. Charging Flue Gate
4. Grate
5. Cycling Time Clock
6. Overfire Air (and Fan)
7. Underfire Air
8. Draw a line showing the path of the garbage.



For good combustion, be sure there is a good basic air supply to the incinerator room.

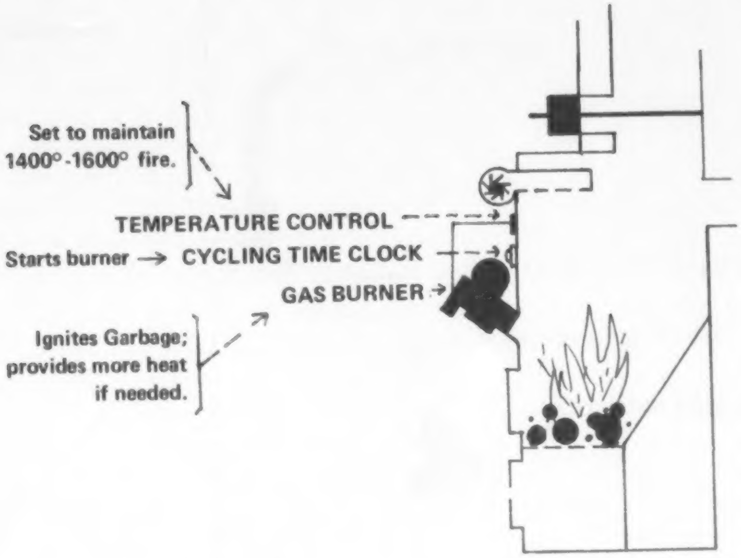
– Check and correct your answers.

ANSWERS TO PREVIOUS PAGE.


CHARGING FLUE
HOPPER DOOR
CHARGING FLUE GATE
OVERFIRE AIR FAN
CYCLING TIME CLOCK
GRATE
UNDERFIRE AIR

IGNITION AND HEAT – THE BURNER

For a hot, fast burn the three parts below must be working properly.


Set to maintain 1400°-1600° fire.
TEMPERATURE CONTROL
Starts burner → CYCLING TIME CLOCK
GAS BURNER
Ignites Garbage; provides more heat if needed.

ANSWER THESE QUESTIONS:

1. What starts the burner at firing time?
2. What ignites the garbage (starts the fire)?
3. What instrument monitors the fire temperature?

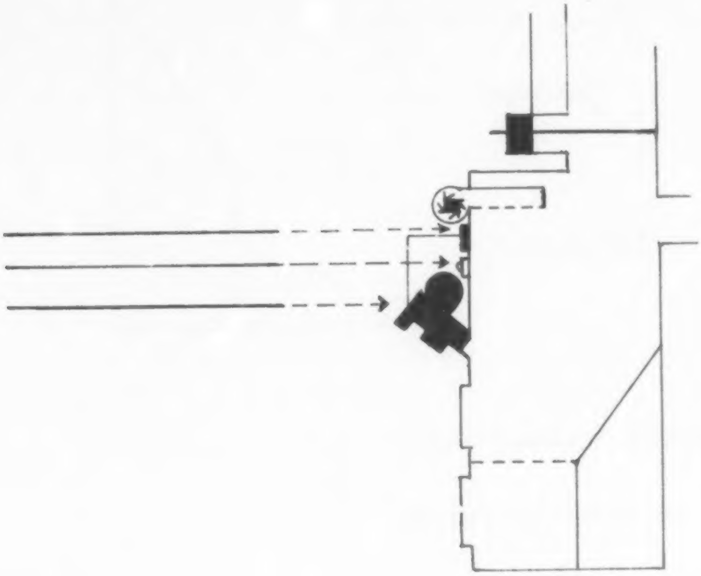
– Check your answers.

1. **Cycling Time Clock**
2. **Gas Burner**
3. **Temperature Control**

The burning chamber is closed off when the Charging Flue Gate closes. It closes after dropping garbage to the grate. It stays closed during the burn and collects garbage for the next burn.

PUT THE NAMES OF THESE PARTS ON THE DIAGRAM:

1. **This starts the burner (also controls garbage and air)**
2. **This ignites the garbage**
3. **This keeps the fire between 1400F - 1600 F.**



Check and correct your diagram by the previous page.

CIRCLE THE CORRECT WORDS:

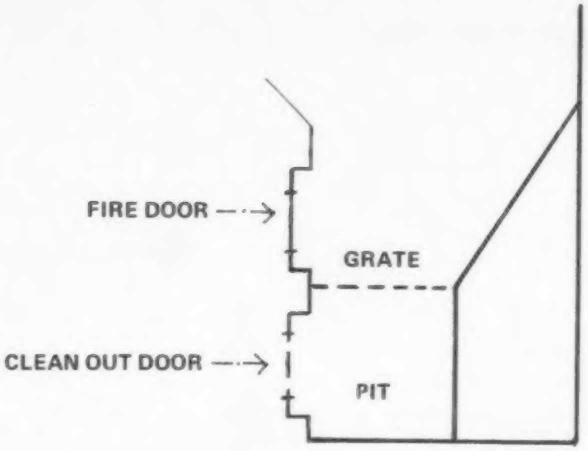
A good incinerator burn is HOT/WARM and SLOW/FAST.

– Check your answer.

4. AFTER THE BURN

You are probably no longer surprised at the junk that ends up in your incinerator.

Here is the area to clean after the burn, when the incinerator is COOL.



1. Where will cans and bottles be left after the burn? ____________________

2. Where will the ashes fall during and after the burn? ____________________

3. Through what door would you clean the grate? ____________________

4. Through what door would you remove ash that had fallen through the grate? ____________________

– Check your answers.

1. On the grate
2. Pit under Grate
3. Fire Door
4. Clean out door

5. BURNING REVIEW

1. What three things are needed for a burn? ____________________
____
____

2. What device controls these three to start the burn? ____________________

3. What part holds the garbage, then opens to allow it to fall into the burning chamber? ____________________

4. Name the two air sources to the fire chamber. ____________________
____

5. What piece of equipment ignites the garbage? ____________________

6. What device monitors the burn for correct temperature? ____________________

7. What two places need to be cleaned after the fire is out? ____________________
____

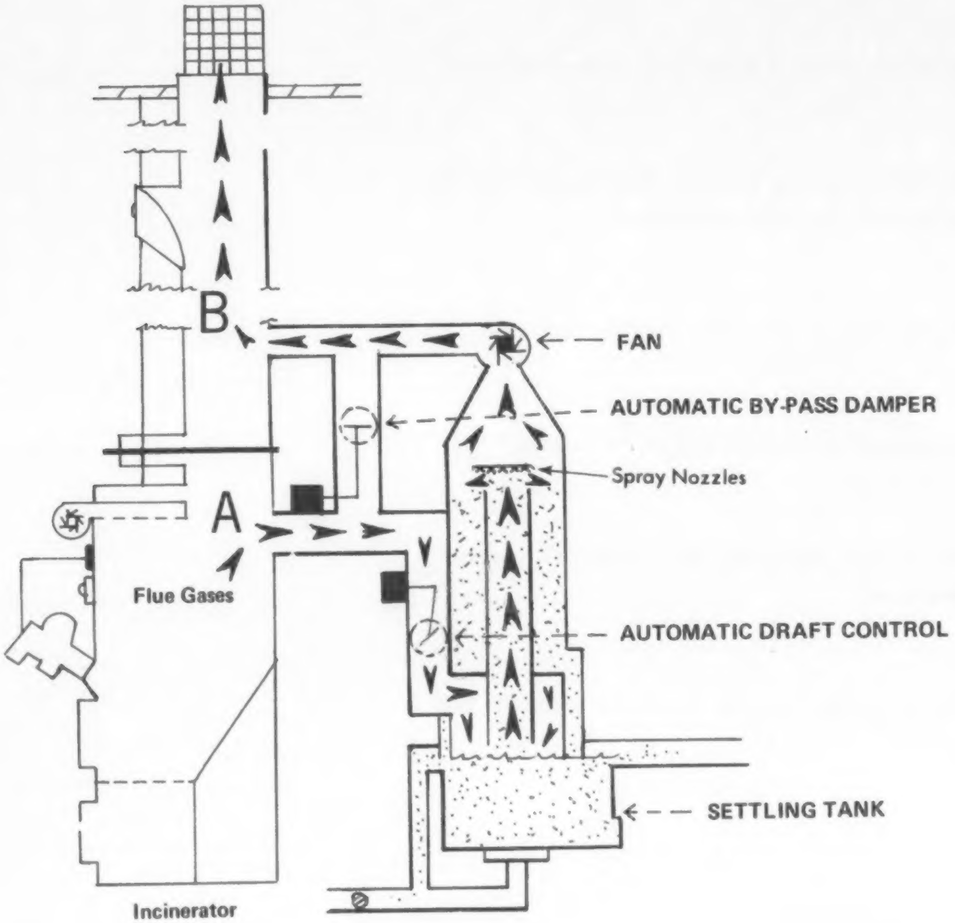
ANSWERS

1. Garbage
   Air
   Ignition (Burner)
2. Cycling Time Clock
3. Charging Flue Gate
4. Overfire Air
   Underfire Air
5. Gas Burner
6. Temperature Control
7. Grate
   Ash pit under Grate

6. SCRUBBING THE GASES

New York City upgrading standards require all incinerators to have a SCRUBBER. As the garbage is burned the EXHAUST GASES ARE CLEANED BY BEING WASHED VIGOROUSLY WITH WATER before going out the Stack.

Here is a basic Scrubber diagram.


B
FAN
AUTOMATIC BY-PASS DAMPER
Spray Nozzles
A
Flue Gases
AUTOMATIC DRAFT CONTROL
SETTLING TANK
Incinerator

Answer these questions as to how the Scrubber works:

_______ 1. Gases from the burning **refuse** are pulled into the Scrubber by:

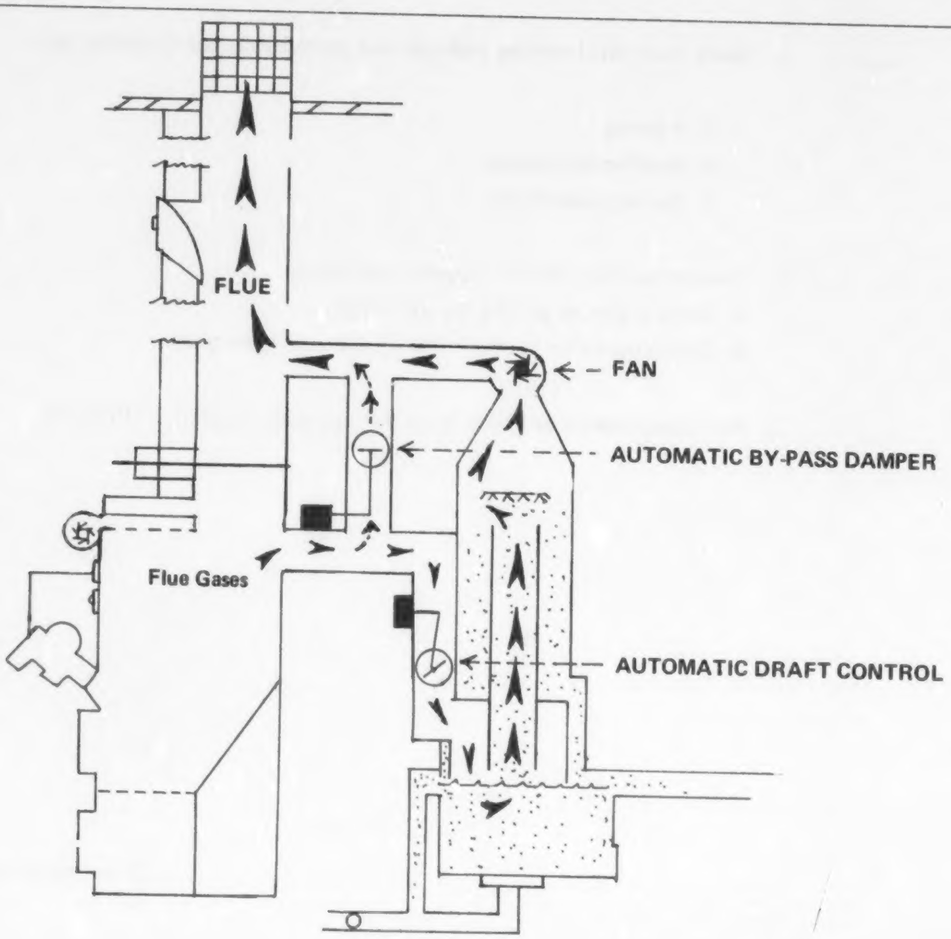
A. a pump
B. overfire air supply
C. fan induced draft

_______ 2. The dotted area on the diagram represents:
A. Quiet water to let the fly ash settle.
B. Churning water to wash the fly ash from the gases.

_______ 3. Are gases cleaner at Point A on the opposite diagram or Point B?

– Check your answers.

C 1.
B 2.
B 3.



Gases are moved by a FAN and controlled by a DAMPER and DRAFT CONTROL. Normally the AUTOMATIC DRAFT CONTROL **valve is left in the open position to allow the gases to pass into the scrubber. The purpose of the automatic draft control is to maintain a low uniform draft in the incinerator.** When the scrubber is temporarily shut down for cleaning or maintenance or an emergency such as water failure, the AUTOMATIC BY-PASS DAMPER is adjusted so that gases are directed past the scrubber and up the stack without being cleaned.

MATCH the devices with what they do:

____ Automatic By-Pass Damper
____ Automatic Draft Control
____ Fan

A. Pulls gases from the Scrubber water and out the flue.
B. Directs gases from the burn on out the flue without going through the Scrubber.
C. Directs gases from the burn into the Scrubber.

B Automatic By-Pass Damper

C Automatic Draft Control

A Fan

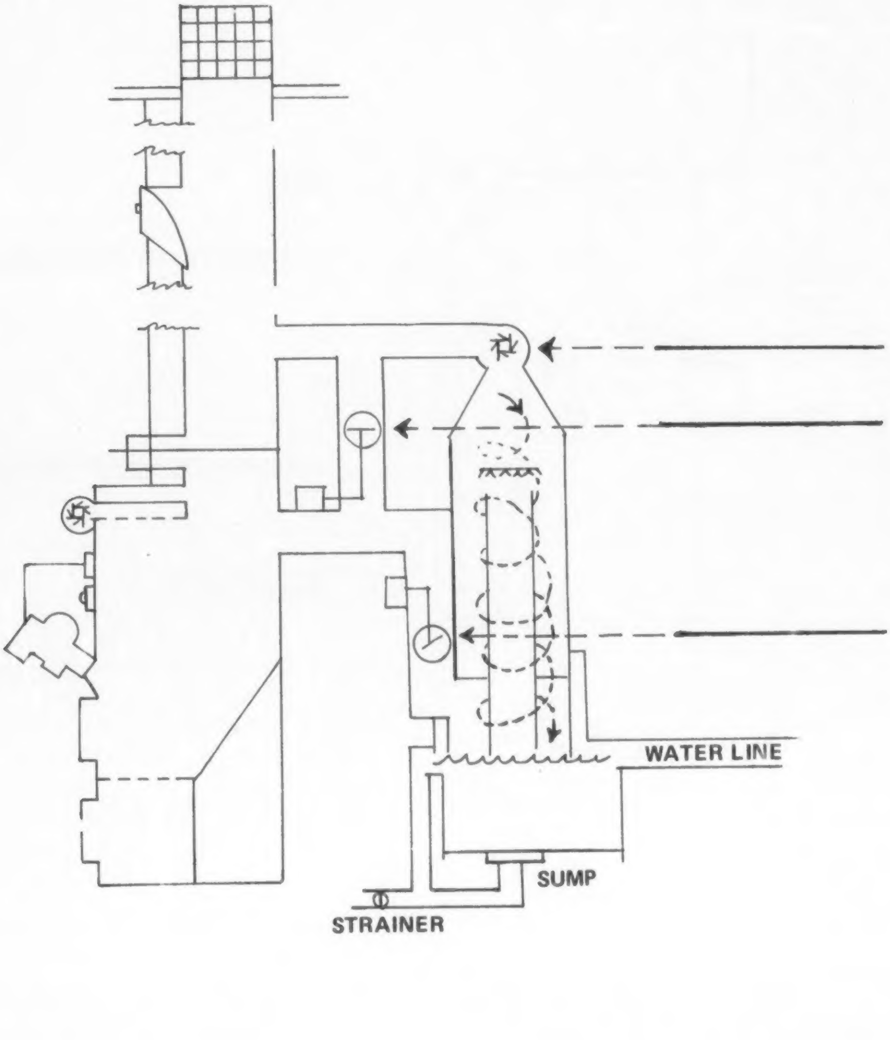
On the diagram, LABEL THESE PARTS:

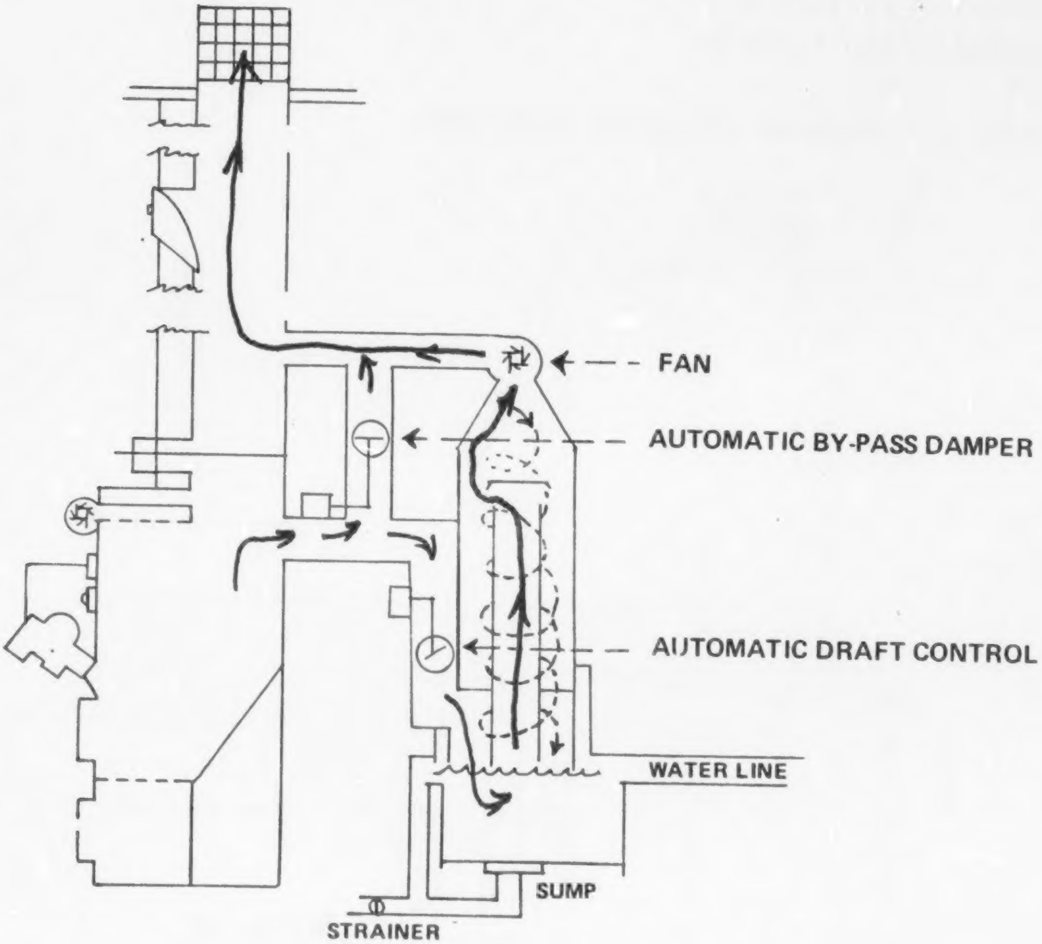
AUTOMATIC BY-PASS DAMPER

AUTOMATIC DRAFT CONTROL

FAN

DRAW A LINE SHOWING THE PATH OF FLUE GASES


WATER LINE
SUMP
STRAINER


FAN
AUTOMATIC BY-PASS DAMPER
AUTOMATIC DRAFT CONTROL
WATER LINE
SUMP
STRAINER

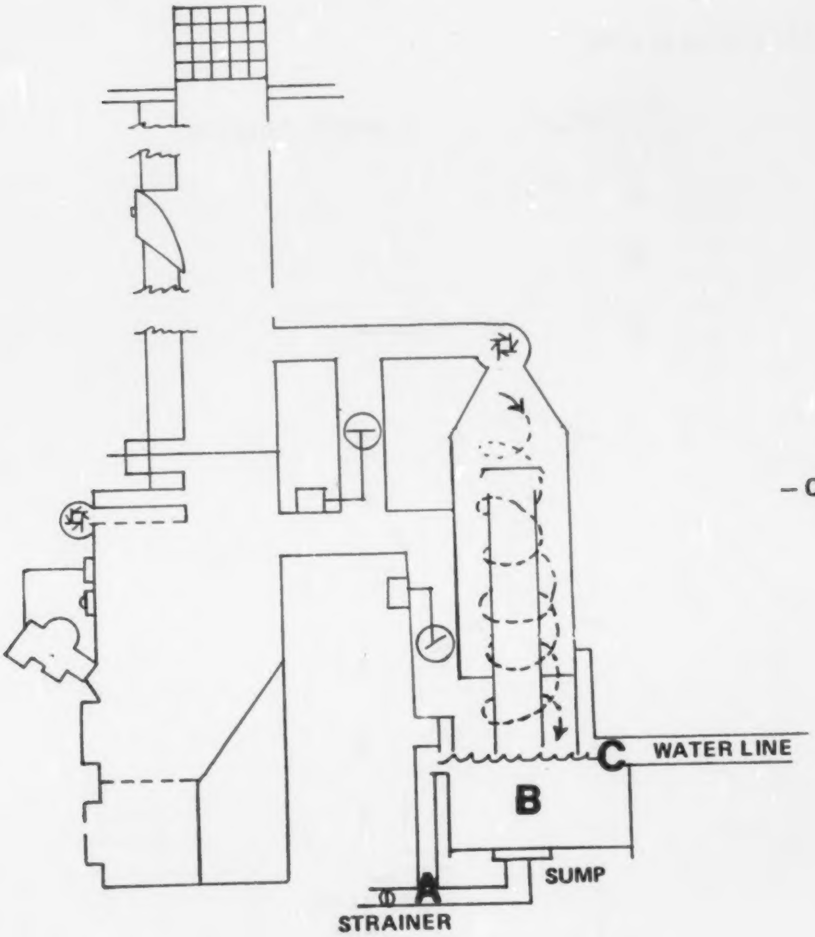
The water in the Scrubber is churning vigorously – **DIRT** and **ASH SETTLE** in the **TANK** at the bottom.

Answer these questions with one of the **LETTERS FROM THE DIAGRAM BELOW**:

_____ 1. At what point does water enter the scrubber?

_____ 2. At what point does water leave the scrubber?

_____ 3. What letter indicates the Settling Tank where dirt will collect?



– Check your answers.

C 1.
A 2.
B 3.

---

7 ASH CATCHERS

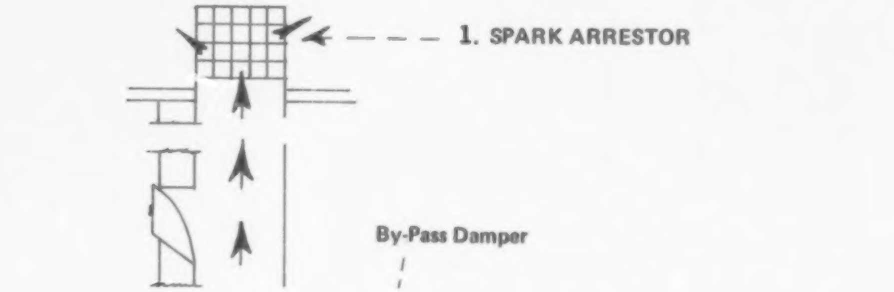
ASH in the scrubber will either

1. SETTLE in the tank, or be
2. CARRIED OUT THE WATER LINE with the water.

Little ash will go up the stack.

When the BY-PASS DAMPER is OPEN all the ash floats freely up the stack. The gases do not go through the scrubber.

SEE THREE ASH CATCHERS BELOW:


1. SPARK ARRESTOR
By-Pass Damper
SETTLING TANK
2. SUMP
3. WATER LINE STRAINER

Answer these questions with a part from the diagram:

1. Where do you clean out the settling tank? ______________________________

2. What filters ash from the water as it leaves the tank? ______________________________

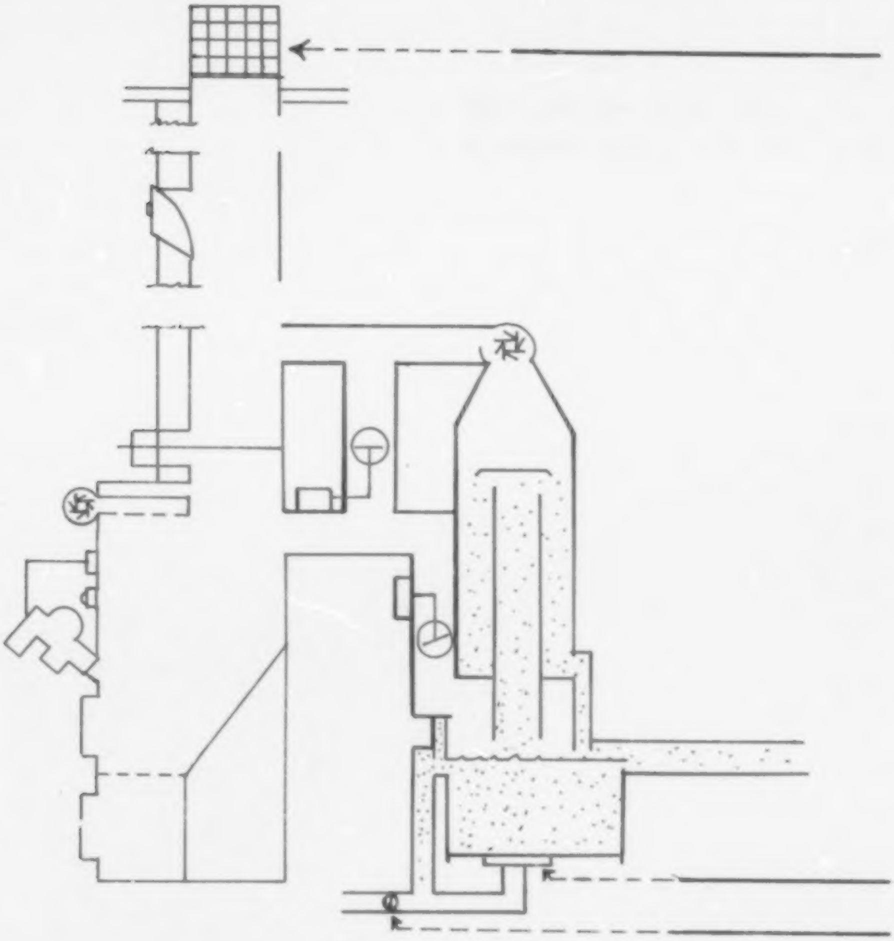
3. What is the only device which will stop large burning material when the by-pass damper is open? ______________________________

– Check your answers

1. Scrubber Sump
2. Water Line Strainer
3. Spark Arrestor

On the diagram below, LABEL THE ASH CATCHERS:

SUMP
WATER LINE STRAINER
SPARK ARRESTOR



CHECK YOUR ANSWERS ON PAGE 172.

Which of these can you clean? ______________________

– Check your answer.

all of them

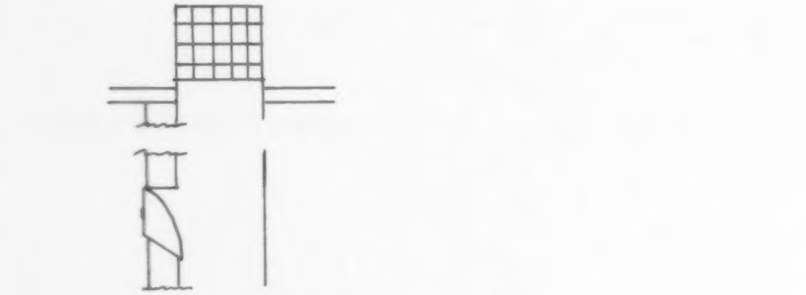
8. SCRUBBER REVIEW

Below is an outline of an Incinerator-Scrubber. In it LABEL OR MARK THE FOLLOWING:

Automatic By-Pass Damper
Automatic Draft Control
Scrubber Settling Tank
Fan
Sump
Water Line Strainer
Spark Arrestor

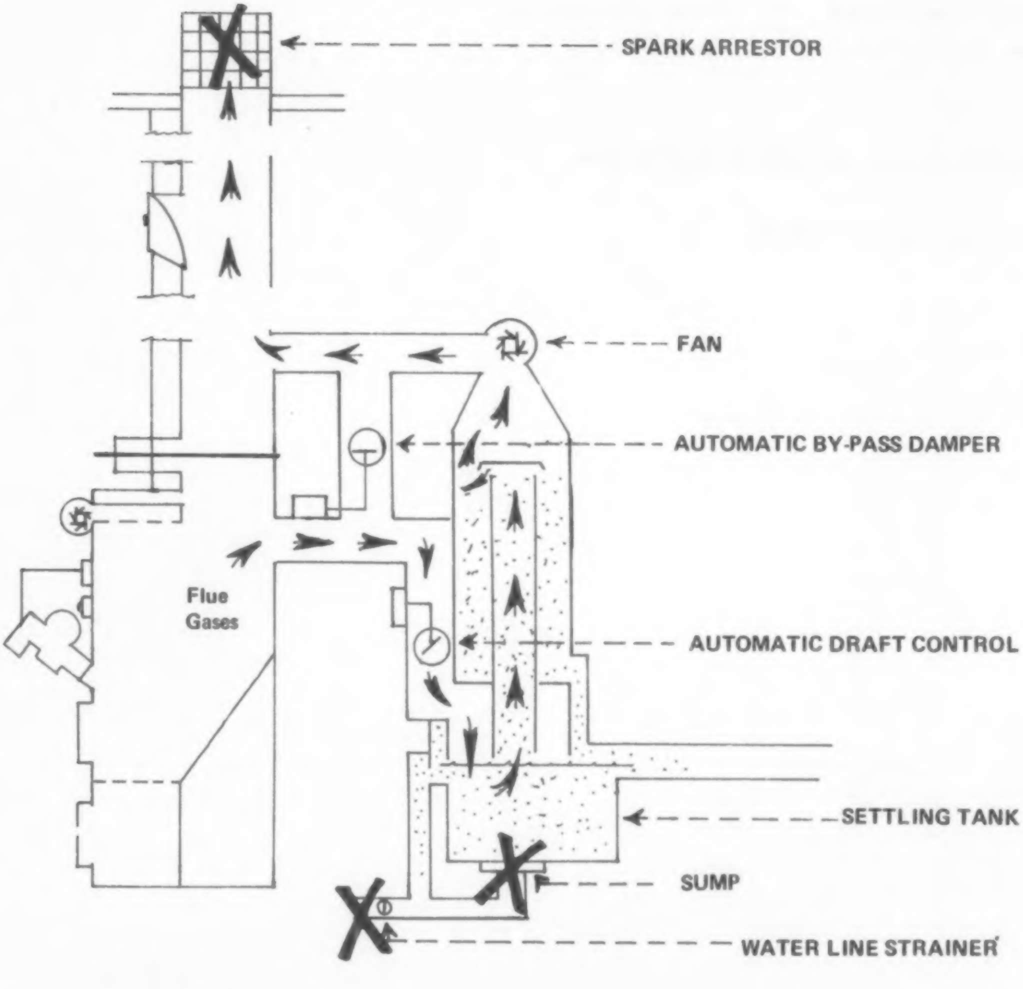
DRAW ARROWS showing the path of the flue gases.

PUT "X" on three ASH CATCHERS.



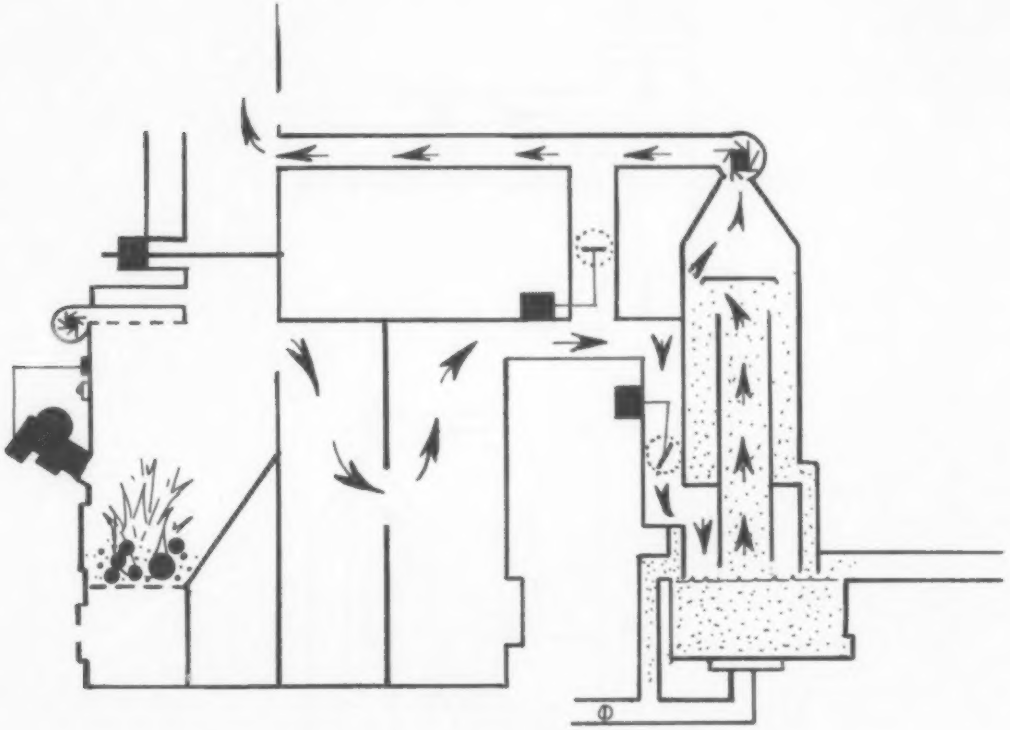
– Check and correct your answers.

ANSWERS TO PREVIOUS PAGE:


SPARK ARRESTOR
FAN
AUTOMATIC BY-PASS DAMPER
Flue Gases
AUTOMATIC DRAFT CONTROL
SETTLING TANK
SUMP
WATER LINE STRAINER

9. MULTI-CHAMBER INCINERATORS

In many systems, gases pass through one or more SEPARATION CHAMBERS AFTER THE BURN. Large residue falls here before gases go into the scrubber.



WRITE "S" IN THE SEPARATION CHAMBERS ABOVE.
WRITE "X" WHERE large ash will fall.

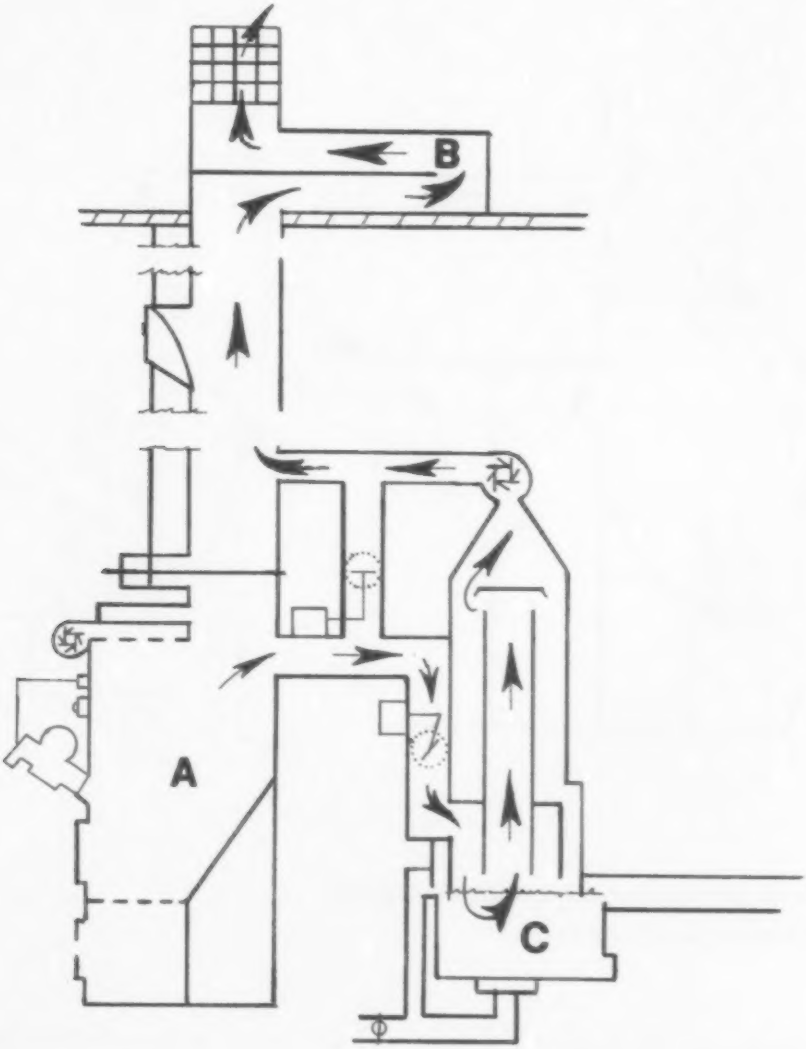
There are two Separation Chambers above. There may be as many as four. The floors should be cleaned regularly.

Does your system have Separation Chambers? ______________________

If so, how many? ______________________

10. ROOF SETTLING CHAMBERS

Some systems have a ROOF SETTLING CHAMBER. ASH settles here before gases go out into the air.



CIRCLE THE CORRECT WORDS:

The roof settling chamber is A/B/C above.

It is useful when the scrubber IS/IS NOT operating

– Check your answers at top of next page.

Answers

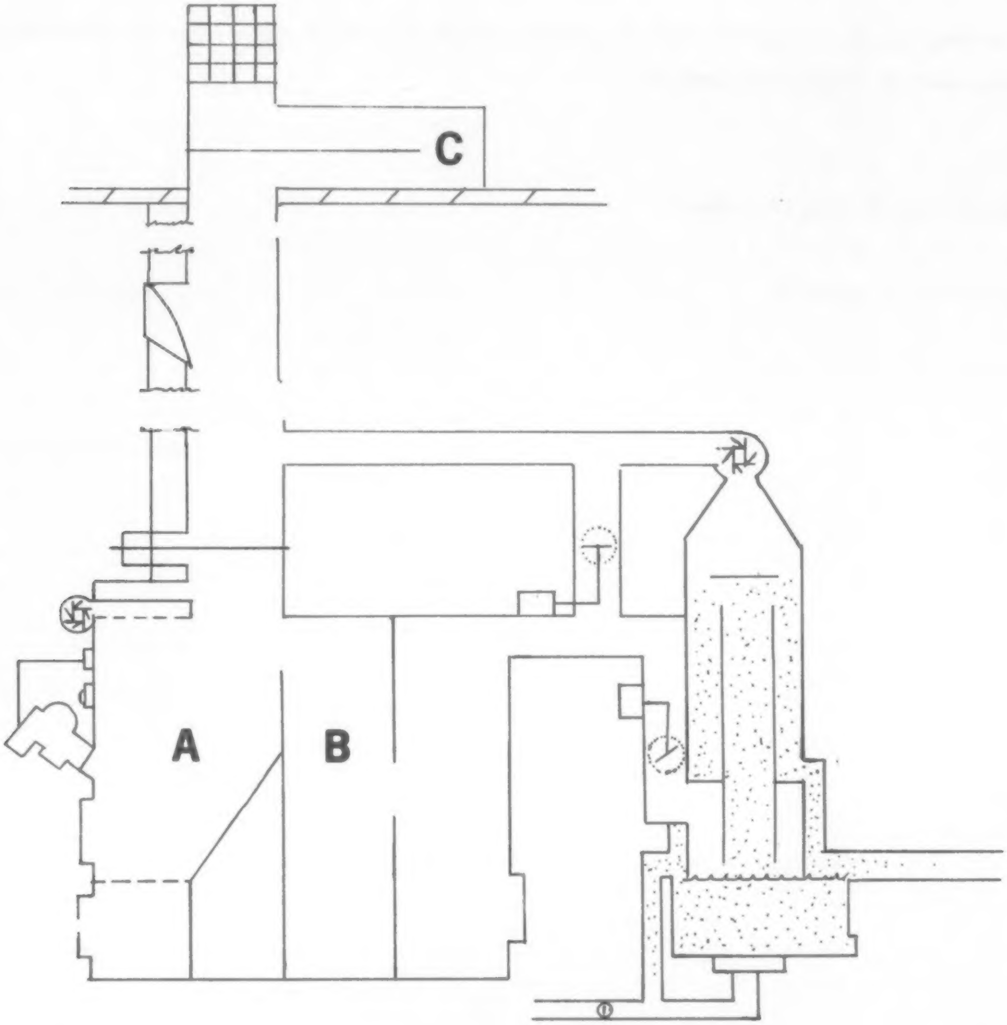
The roof settling chamber is on the roof - B opposite. If the by-pass damper is open (scrubber NOT operating), the roof chamber will collect most large ash.

Do you have a Roof Settling Chamber? ____________________

If so, do you clean it regularly? ____________________

– Go on to the next page.

11. MULTIPLE CHAMBER REVIEW



Name the chambers indicated by the letters above:

A ____________________________________

B ____________________________________

C ____________________________________

A. Burning Chamber
B. Separation Chamber
C. Roof Settling Chamber

---

1. Are the materials collected in B and C mostly fine ash or relatively large particles? ____________________

2. Which chamber cleans gases before the scrubber? ____________________

3. Which cleaning chamber is important when the scrubber is not in use? ____________________

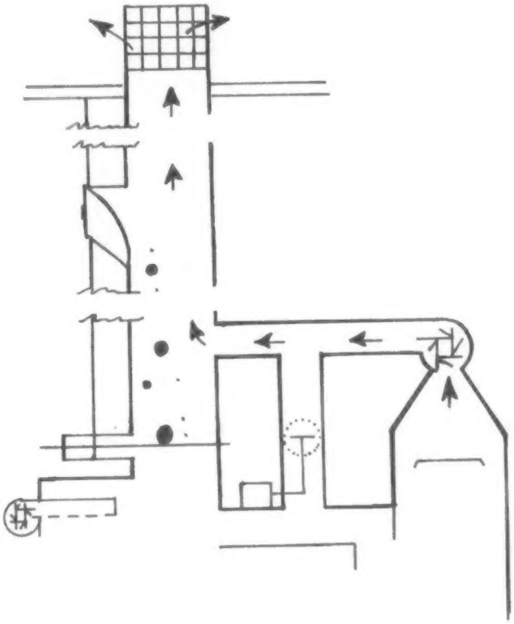
– Check your answers.

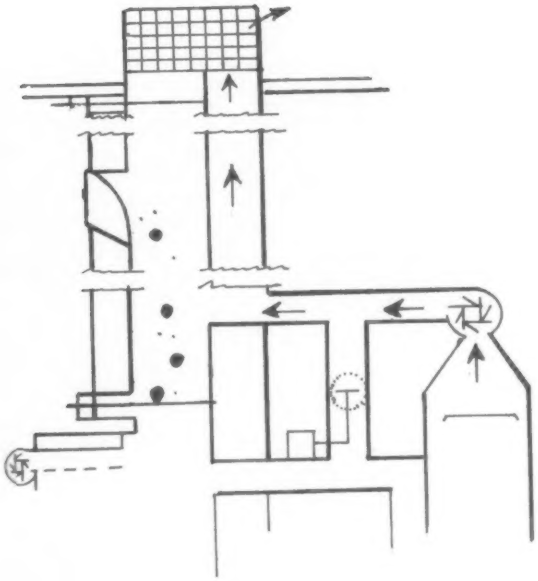
1. large particles
2. B - Separation Chamber
3. C - Roof Settling Chamber

DOUBLE FLUES

Some incinerators have DOUBLE FLUES. So far only single flues have been shown.

LOOK AT THESE DIAGRAMS.





ANSWER THESE QUESTIONS WITH "A" or "B."

____ 1. Which is a single flue?

____ 2. Which is a double flue?

____ 3. Which uses the same flue for garbage going down and gases going up?

____ 4. Which uses separate flues for garbage and gases?

Check and correct
your answers ⇩

A 1.

B 2.

A 3.

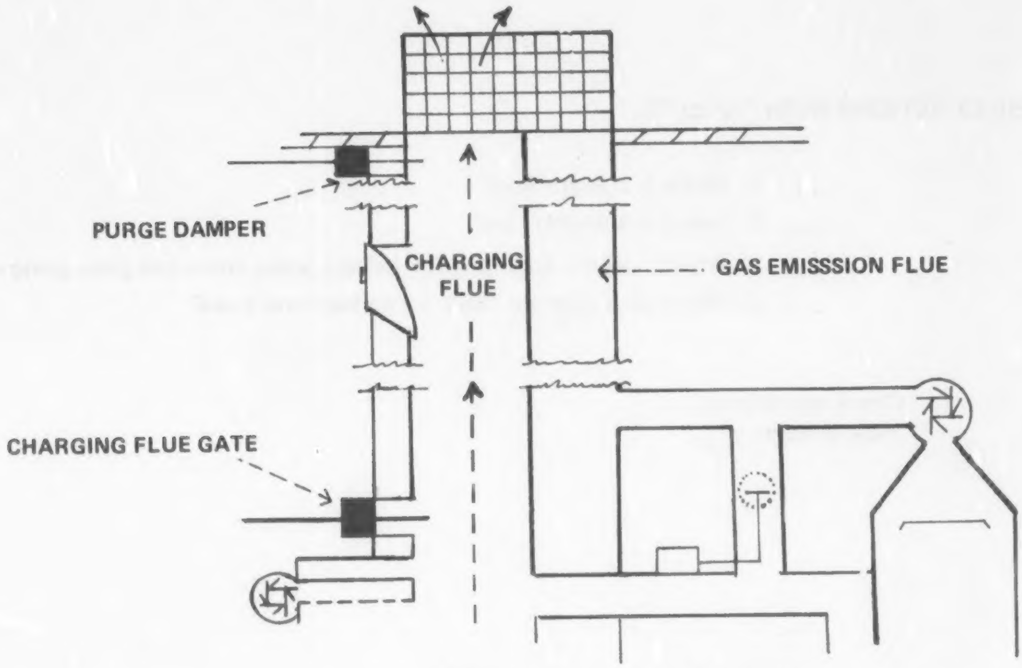
B 4.

Separate flues are a big advantage. Tenants can put garbage in the hopper any time without the danger of hot gases and flying ash.

Separate flues are shown in B and questions 2 and 4 above.

Single flue hoppers should automatically lock during burning. This is very important for safety and should be checked regularly.

Do you have a Single or Double flue incinerator? ______________________


PURGE DAMPER
CHARGING FLUE
GAS EMISSSION FLUE
CHARGING FLUE GATE

DOUBLE FLUE INCINERATOR

A PURGE DAMPER allows periodic cleaning of the Charging Flue. Garbage, grease and insects are burned off by automatic sequence of the steps below:

TURN GAS BURNER ON
OPEN PURGE DAMPER
OPEN CHARGING FLUE GATE
SHUT DOWN SCRUBBER

Hot gases then go straight up the Charging Flue and clean it. Dotted line above show the path of these gases.

1. Waste gases normally go up which flue? ____________________

2. When cleaning the charging flue, hot gases are directed up which flue? ____________________

3. A purge damper is needed in double flue incinerators because:

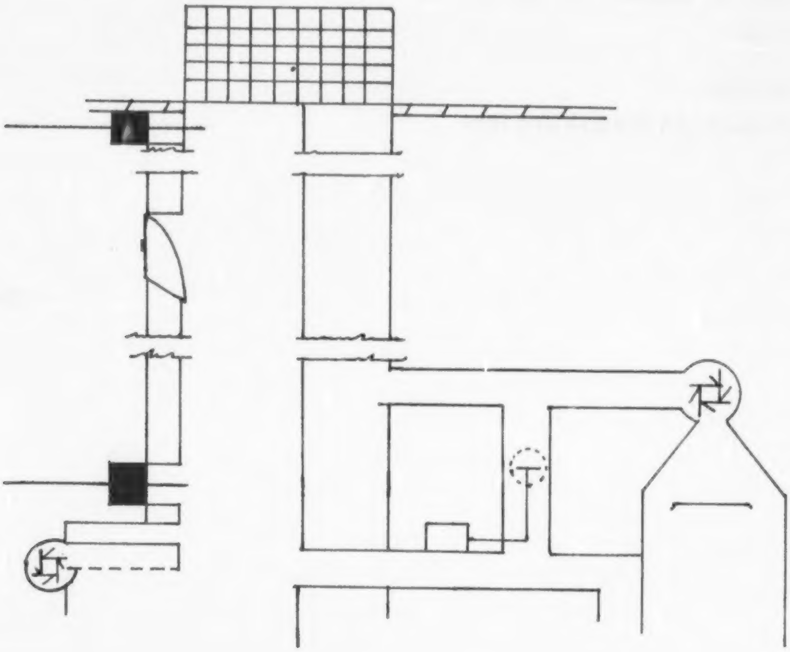
   A. It controls the draft.
   B. It is needed to burn out the charging flue. ____________________

– Check your answers.

1. Gas Emission Flue
2. Charging Flue
3. B

---

13. DOUBLE FLUE REVIEW



On the diagram –

LABEL the CHARGING FLUE
LABEL the GAS EMISSION FLUE
LABEL the PURGE DAMPER
DRAW A LINE showing the path of hot purge gases.
DRAW ARROWS showing the normal path of gases from the scrubbers.

CHECK YOUR DIAGRAM ON PAGE 184, correct it if necessary.

HANDBOOK WRAP-UP

This completes the introduction to basic incinerator parts. Your system may not exactly match the diagrams shown but it should be similar.

TURN TO YOUR INCINCERATOR HANDBOOK, PAGE 221.

PAGE 222	Basic parts and definitions are included here for your future reference.
PAGE 224	Here is a general incinerator outline. On it LABEL THINGS ABOUT YOUR INCINERATOR THAT ARE DIFFERENT FROM THE EXAMPLE IN THIS LESSON. (You may have a different type of Scrubber).
PAGE 225	RECORD THE STATISTICS OF YOUR SYSTEM HERE.

SUMMARY

These questions review the important things in this section:

1. Is a good incinerator fire hot and fast or moderate and slow? ____________________

2. What three basic ingredients are needed for an incinerator fire? ____________________

____

____

3. What device is set to coordinate the burn (drop the garbage, start the overfire air, start the burner)? ____________________

4. What part of the incinerator actually holds the garbage above the furnace until firing time? ____________________

5. Name the two direct air supplies to the fire? ____________________

____

6. Which can be regulated, Overfire Air or Underfire Air? ____________________

7. What two places under the furnace collect waste bottles, cans and ash? ____________________

8. What major device should all incinerators have to clean flue gases? ____________________

9. What circulates in the scrubber to clean the flue gases? ____________________

10. Are flue gases pulled from the furnace into the scrubber by the automatic draft control or by-pass damper? ____________________

11. Are the flue gases directed out the flue without going through the scrubber by the automatic draft control or by-pass damper? ____________________

12. What is at the bottom of the settling tank which collects dirt and must be cleaned regularly? ____________________

13. What device should be in the water line leaving the scrubber to collect ash in the water? ____________________

14. What device pulls gases from the scrubber and out the flue? ____________________

15. What are separation chambers used for? ____________________

16. A double flue incinerator is one that permits you to switch garbage collection from one to the other. (TRUE or FALSE) ____________________

ANSWERS TO REVIEW QUESTIONS:

1. hot and fast
2. garbage
   air
   ignition (burner)
3. cycling time clock
4. charging flue gate
5. overfire air (blower)
   underfire air
6. overfire air
7. grate
   ash pit
8. scrubber
9. water
10. draft control
11. by-pass damper
12. sump
13. strainer
14. fan
15. cleaning the gases, collecting ash
16. False

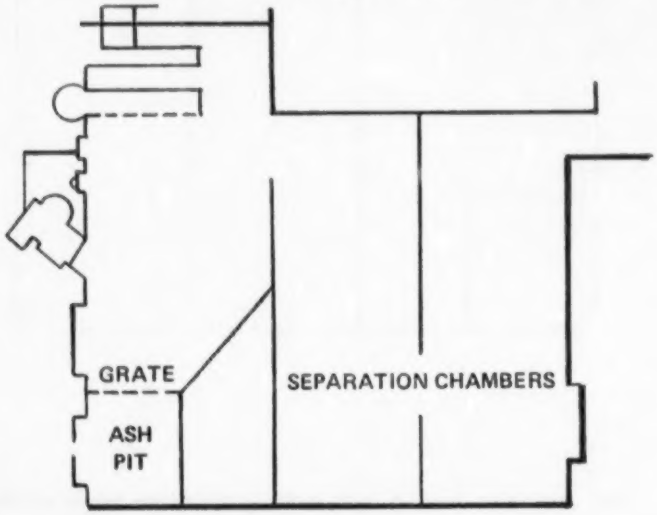
Section 6
INCINERATORS; MAINTENANCE AND TROUBLESHOOTING
including your own INCINERATOR HANDBOOK

1. DAILY CLEANING

This section will cover tasks you should do each day to keep the system running smoothly and maintenance tasks to be performed periodically. Also included are troubleshooting checks to make before calling service should you get smoke.

Daily Cleaning reduces your chances of producing smoke. Your system will not work smoothly if clogged with waste from burning.

Set a time each day to clean and check the incinerator. WAIT AT LEAST ONE HOUR after a burn for the furnace to cool. SHUT DOWN THE SYSTEM by pushing the stop button. BELOW ARE THREE PLACES to clean.



1. How long should you wait after a burn to clean the incinerator? ________________

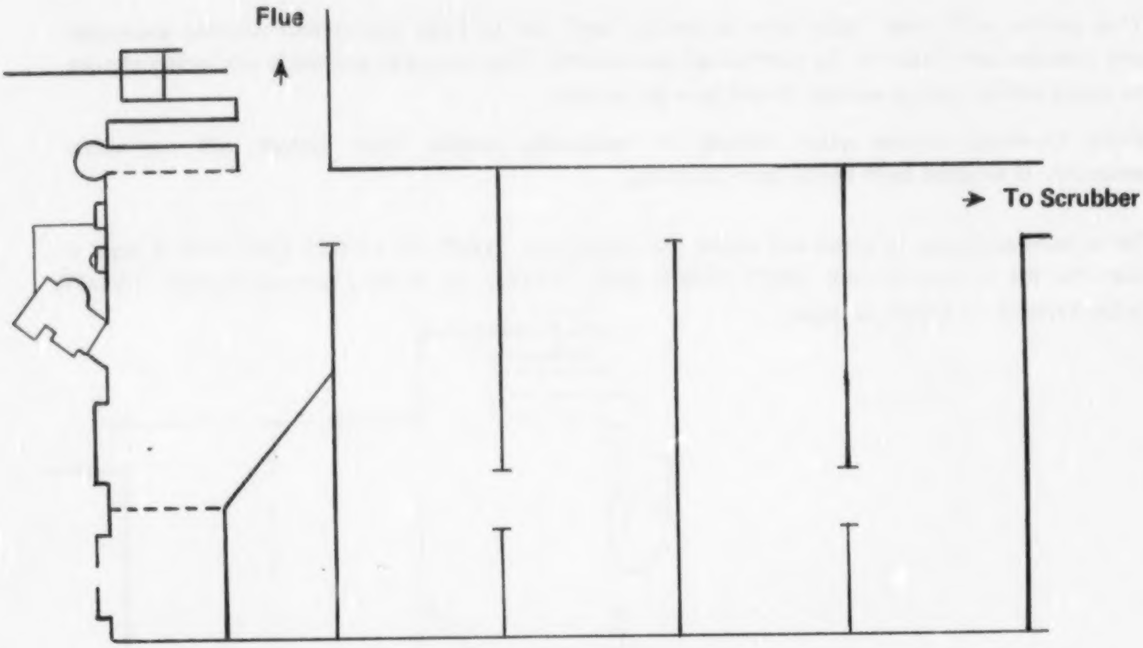
2. From where would you clean cans, bottles and other large waste material? ________________

3. From where would you clean most of the ash? ________________

– Check your answers.

1. 1 hour or more
2. Grate
3. Ash Pit

On this diagram, MARK AN "X" on the number of SEPARATION CHAMBERS that you have on your system. Leave this blank if you have none.



You may also have a roof settling chamber. Some systems have the scrubber and chambers on the roof.

Name the three places covered so far to be cleaned each day.

____

____

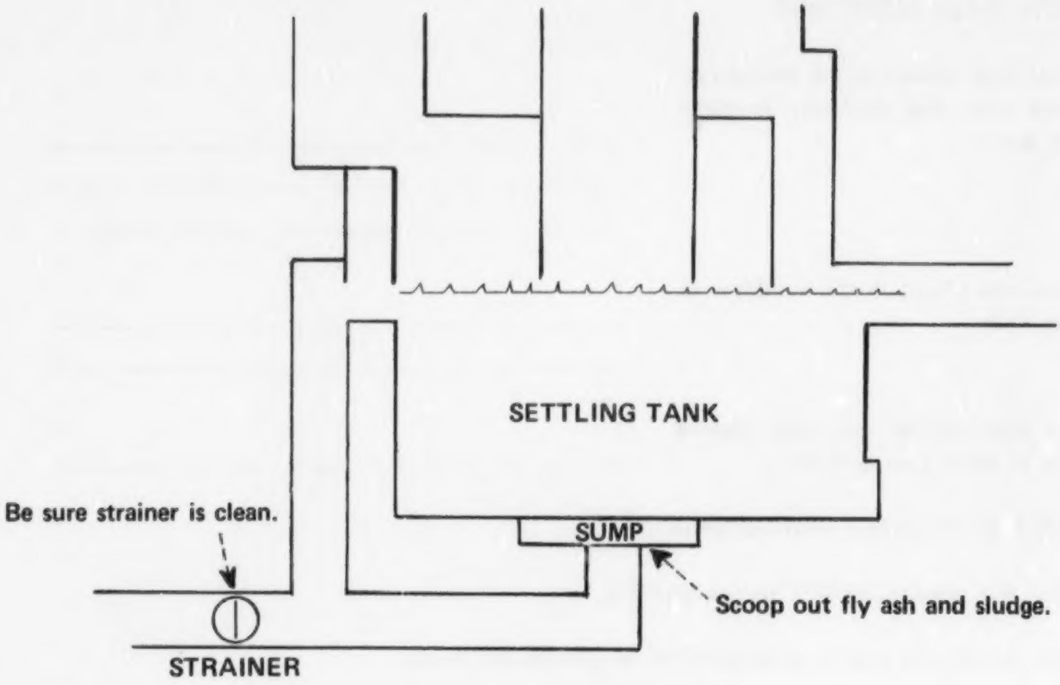
____

– Check your answers.

Grate
Ash Pit
Separation Chambers

---

2. DAILY SCRUBBER CLEANING


SETTLING TANK
Be sure strainer is clean.
SUMP
Scoop out fly ash and sludge.
STRAINER

1. Where will most of the fly ash in the settling tank collect? ______________________

2. What must be cleaned to prevent the discharge water line from clogging? ______________________

After cleaning, be sure all incinerator doors are closed and turn the system back to automatic.

– Check your answers.

1. sump
2. strainer

---

3. DAILY CLEANING REVIEW

ANSWER THESE QUESTIONS:

1. Name three places in the incinerator (other than the scrubber) to clean each day. ____________________
____
____

2. Name two places in the scrubber to clean daily. ____________________
____

3. How long should you wait after a burn to clean your system? ____________________

CIRCLE THE CORRECT WORDS below:

4. Turn your system ON/OFF before cleaning.

5. After cleaning be sure to OPEN/CLOSE all incinerator doors.

ANSWERS

1. Grate
   Ash Pit
   Separation Chambers

2. Sump
   Strainer

3. 1 hour

4. OFF

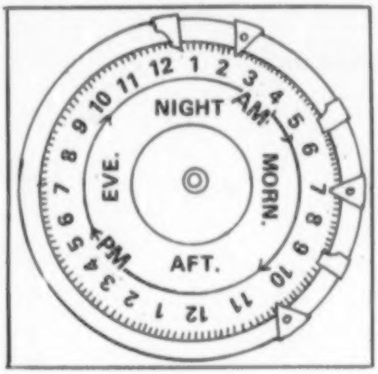
5. CLOSE

4. DAILY CHECKS

In addition to cleaning, there are some DAILY CHECKS to make to keep major parts in good working order.

CYCLING TIME CLOCK

ON THIS CLOCK, CIRCLE THE TIMES YOUR CLOCK IS SET to start a burn:



The clock is important as it brings together burning ingredients - garbage, air, ignition. If your clock isn't working, call service to fix it.

Whom do you call for incinerator service? ______________________________

Do you have his number at a convenient place for easy access? ______________________________

Incinerator service agencies usually repair all equipment.
What is the first daily check to make? ______________________________

– Check your answer.

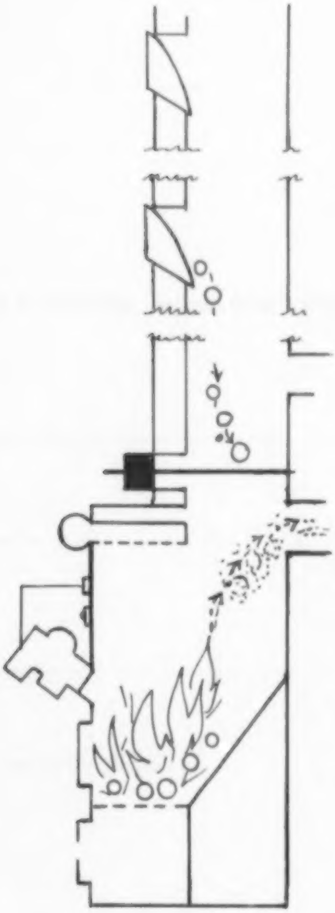
5. FLUE GATE

Next, check the CHARGING FLUE GATE.

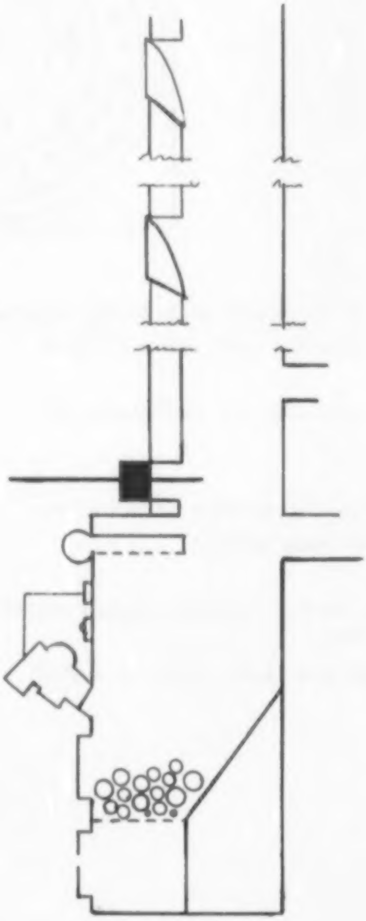
Assume the following for the cases below:

Time clock is set at 10:00 A.M. and is working.
Time is now 10:30 A.M.

CIRCLE THE CORRECT WORDS under each:



1.
Charging gate apparently
JAMMED/WORKING



2.
Charging Gate apparently
JAMMED/WORKING

The first incinerator has started to burn and is OK. The second is jammed in the open position. It could also jam closed or partially open.

If the charging gate becomes jammed, check to see if GARBAGE is BLOCKING the gate or track. If not, the ACTUATOR PISTON may not be working. It is usually operated by water pressure. If your basic utilities (electric supply, city water pressure) are OK, call service.

1. What two things should you check if your charging gate becomes jammed? ______________________________

   ____

2. Name two daily equipment checks to make. ______________________________

   ____

– Check your answers.

1. Garbage blocking gate
   Actuator Piston working
2. Cycling Time Clock
   Charging Flue Gate

---

6. LAST TWO DAILY CHECKS:

BLOWER MOTOR – OVERFIRE AIR	Sound normal?
GAS BURNER	Sound normal? Spark Plugs connected? Gas cock open?

You will normally not have problems with the above, but they are important. Be sure they are in good working order.

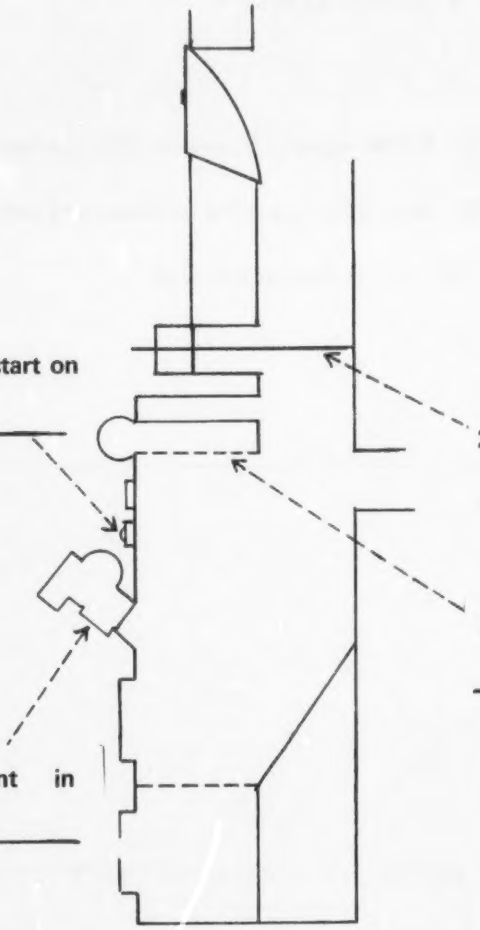
1. What air source has movable parts and should be checked daily? ______________________________

2. What part is checked to confirm dependable ignition? ______________________________

– Check your answers.

1. Blower - Overfire Air
2. Gas Burner

COMPLETE DAILY INCINERATOR CHECKS BELOW:



1. For the system to start on time: __________

2. Garbage drops to burn properly __________

3. Air is getting to the furnace: __________

4. Ignition equipment in good order: __________

– Check your answers.

1. Cycling Time Clock
2. Charging Flue Gate
3. Overfire Air Blower
4. Gas Burner

---

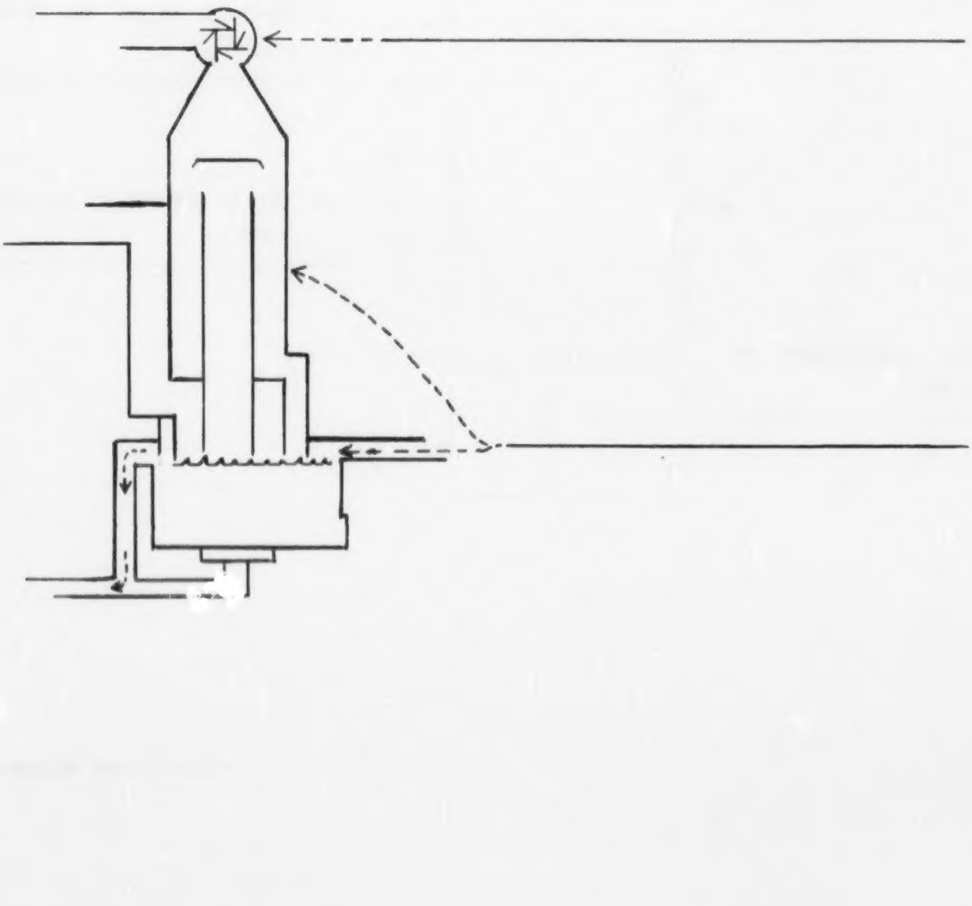
7. SCRUBBER - DAILY CHECKS

TWO SCRUBBER CHECKS:

1. WATER CIRCULATION - water moving vigorously; in and out at proper rate.

2. FAN AND MOTOR WORKING - gases taken from the scrubber and out the flue.

On the diagram WRITE THESE TWO on the appropriate lines.



Water must circulate to clean the gases. The fan (at the top) pulls off gases for discharge. You may have a WATER LEVEL GAUGE to monitor scrubber water.

1. **Is there a water level gauge on your system?** ____________________
2. **How does your scrubber circulate the water (pump, draft pressure, other)?** ____________________
3. **What equipment pushes Scrubber gases out the flue which should be checked daily?** ____________________

– Check your answers.

1. check your own answer
2. check your own answer
3. Fan (and motor)

---

8. REVIEW - DAILY CHECKS

COMPLETE THE DAILY INCINERATOR CHECKS.

1. Cycling ____________ ______________
2. Charging ______________ ______________
3. Overfire Air – ___________________
4. Gas __________________

5. Scrubber – ______________________________ Circulation
6. Scrubber – ______________________________ and Motor.

If you find any sign of trouble which you cannot easily fix, call service before it develops into a major problem.

– Check your answers.

1. **Cycling Time Clock**
2. **Charging Flue Gate**
3. **Overfire Air - Blower**
4. **Gas Burner**
5. **Scrubber - Water Circulation**
6. **Scrubber - Fan and Motor**

This completes the DAILY CLEANING and CHECKING TASKS; they are summarized below.

DAILY CLEANING

1. **Grate**
2. **Ash Pit**
3. **Separation Chambers**
4. **Scrubber Sump**
5. **Scrubber Water Line Strainer**

DAILY CHECKS

1. **Cycling Time Clock**
2. **Charging Flue Gate**
3. **Overfire Air - Blower**
4. **Gas Burner**
5. **Scrubber - Water Circulation**
6. **Scrubber - Fan and Motor**

THESE ARE INCLUDED IN YOUR INCINERATOR HANDBOOK, PAGE 226 FOR FUTURE REFERENCE.

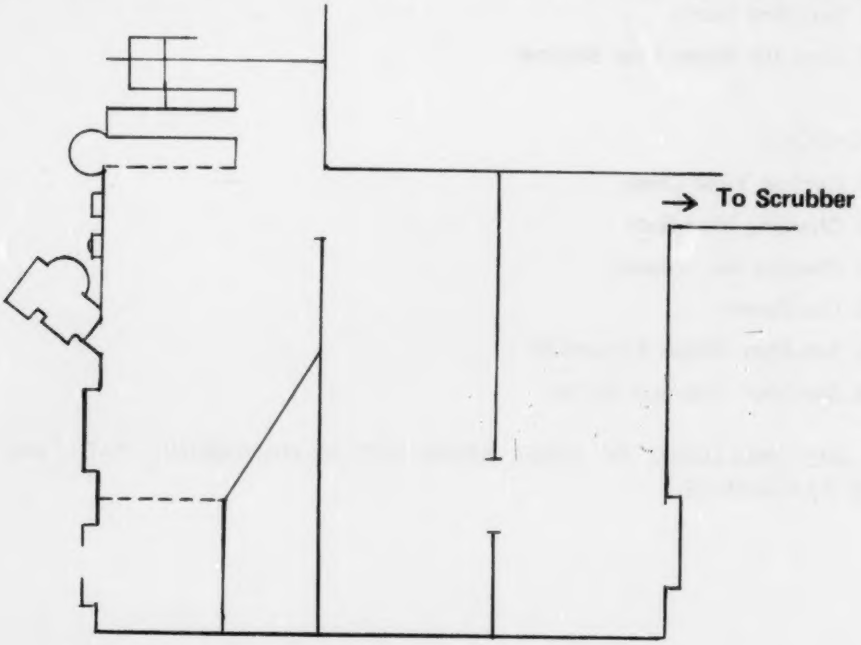
9. PERIODIC MAINTENANCE

There are three cleaning tasks to be done periodically apart from the scrubber. These are: 1) ASH BUILD-UP, 2) CHARGING FLUE PURGE, and 3) SPARK ARRESTOR.

ASH BUILD UP

Even though you regularly clean ash from the floors of your system, there will be build-up on the CHAMBER WALLS and LEDGES.

DRAW LINES ALONG SURFACES on the diagram which you should clean periodically.



You should have indicated ALL INSIDE BURNING AND SEPARATION CHAMBER WALLS AND LEDGES. You normally reach these through access doors.

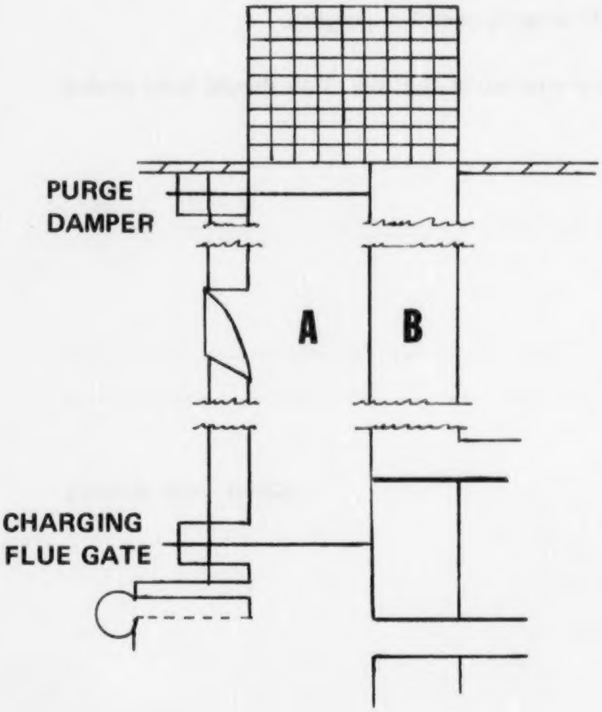
How many chambers do you have to periodically clean for ash build-up? ____________________

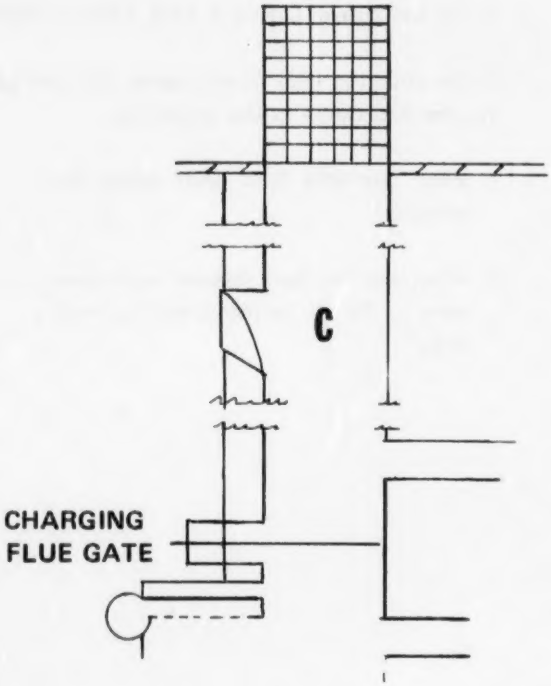
DOUBLE FLUE – PURGE CHARGING FLUE

This task is done only in the case of a double flue incinerator.

As garbage goes down the Charging Flue, a certain amount of GREASE collects on the WALLS and attracts INSECTS.

Look at these flues – ANSWER THE QUESTIONS BELOW:





Which of the flues above has garbage going down *and* gases going up? ____________________

Which flue walls would collect garbage and insects which would not be burned off with each burn? ____________________

Flue C has garbage and gases passing through and is cleaned with each burn. Flue A must be cleaned by purging.

Here's how to purge the charging flue:

1. **PUT SYSTEM ON MANUAL CONTROL**
2. **TURN SCRUBBER OFF**
3. **OPEN BY-PASS DAMPER**
4. **OPEN PURGE DAMPER**
5. **OPEN CHARGING GATE**
6. **TURN GAS BURNER ON**

In the list above, CIRCLE THE TWO DAMPERS to be opened for purging.

If the charging gate is not open, the hot gases cannot enter the flue. You should have circled by-pass and purge in the above list.

1. What provides heat (hot gases) for purging? ______________________

2. What are the two maintenance tasks seen so far to be performed periodically? ______________________

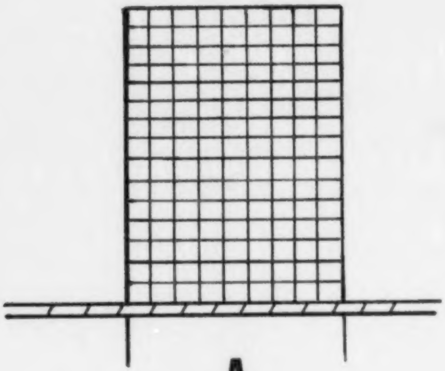
____

– Check your answers

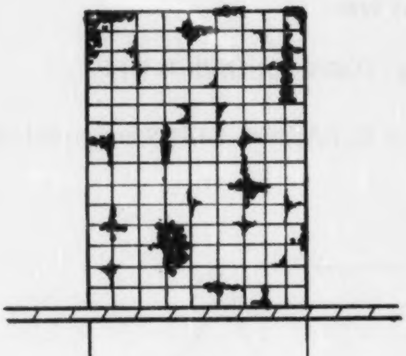
1. Gas Burner
2. Clean ash build-up
Purge charging flue

CLEAN SPARK ARRESTOR

Here are two spark arrestors. ANSWER THE QUESTIONS under them.



A



B

Does A or B show a spark arrestor that may interfere with flue gases? **1** ____________________

Does A or B show a spark arrestor that is in good condition? **2** ____________________

Name three maintenance tasks to be performed periodically in your incinerator.
3 ____________________
4 ____________________
5 ____________________

– Check your answers.

1. Yes, B } The second spark arrestor above needs to be cleaned with a wire brush. The build-up may
2. Yes, A } interfere with some flue gases.
3. Clean ash build-up
4. Purge charging flue
5. Clean spark arrestor

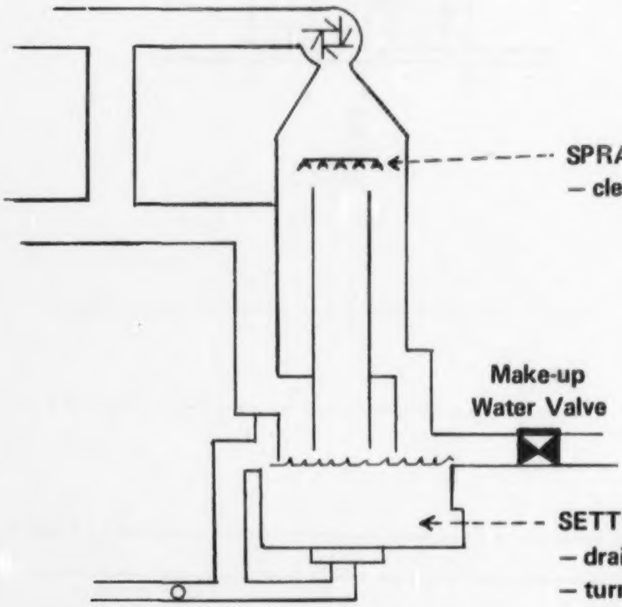
---

10. SCRUBBER MAINTENANCE

All Scrubbers are different. There are three tasks you should perform periodically on yours no matter what the type.

Before cleaning - TURN SCRUBBER OFF.

TWO PERIODIC CLEANING TASKS are on this diagram



SPRAY NOZZLES
– clean with wire brush

SETTLING TANK
– drain, clean, partially refill
– turn scrubber on, check make-up water valve and water control element

1. What do you clean to be sure you have a good water curtain? ______________________

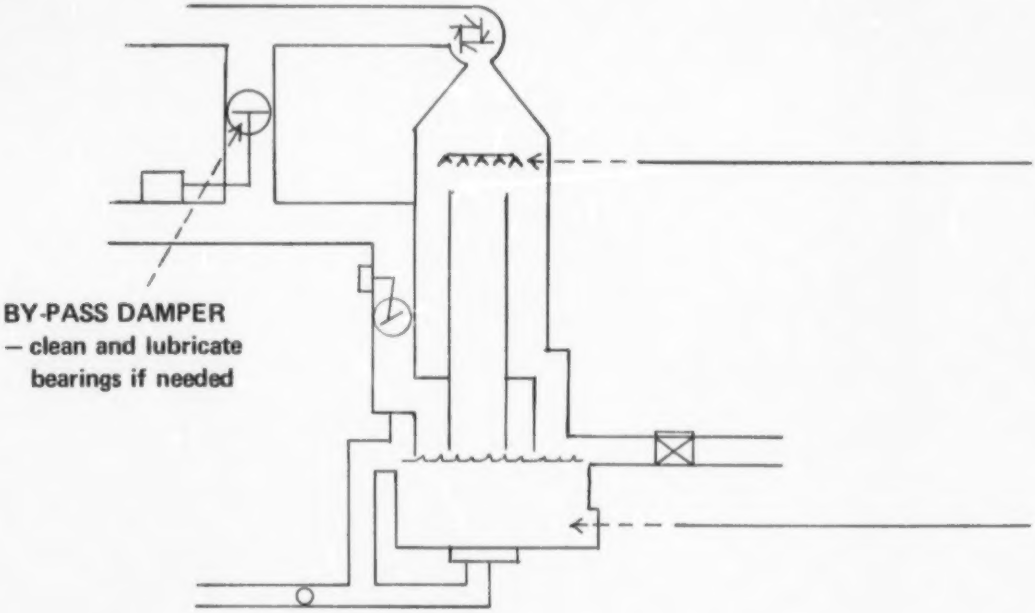
2. What ash-collecting area should be cleaned periodically in the scrubber? ______________________

3. What valve should be checked for adequate water control? ______________________

– Check your answers.

1. Spray nozzles
2. Settling tank
3. Make-up water valve

On the diagram, **LABEL TWO SCRUBBER MAINTENANCE TASKS** just considered.


BY-PASS DAMPER
– clean and lubricate bearings if needed

CHECK AND CORRECT YOUR DIAGRAM using the diagram on page **208.**

The **THIRD SCRUBBER MAINTENANCE TASK** is shown on the diagram above.

1. What damper should be periodically checked for good operation? ____________________

2. What may need to be done to the by-pass damper? ____________________

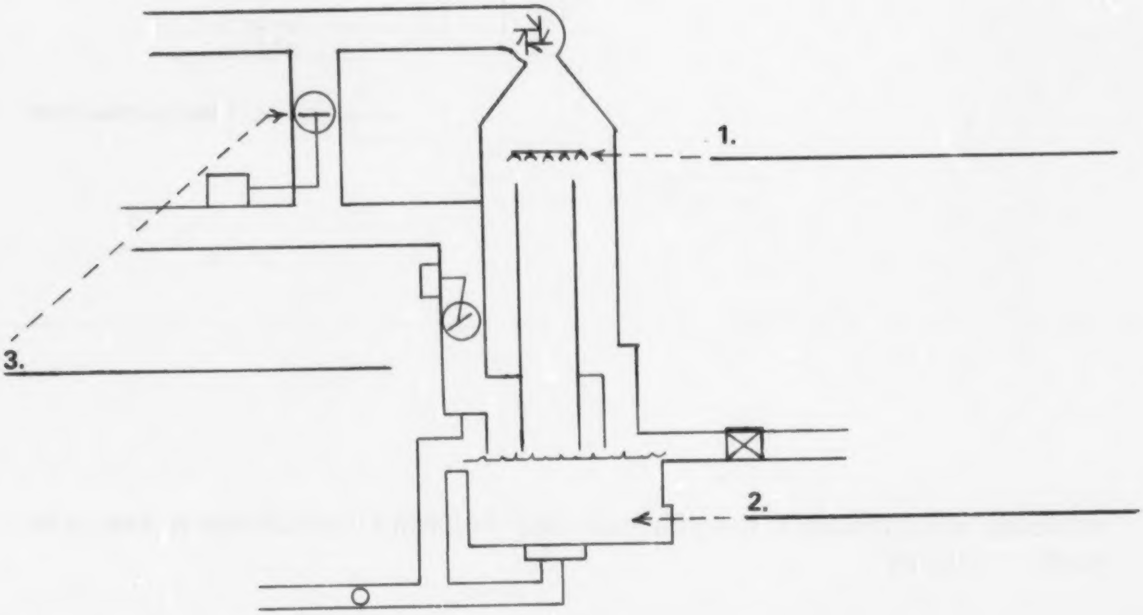
– Check your answers.

1. By-pass damper
2. Cleaned and lubricated

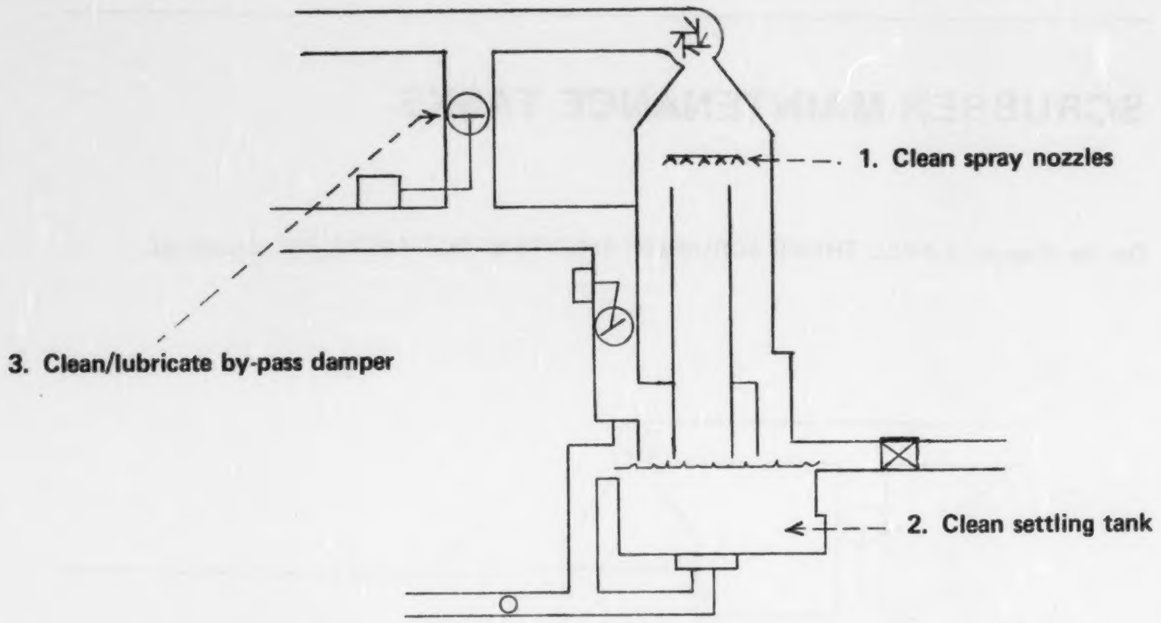
---

11. SCRUBBER MAINTENANCE TASKS

On the diagram, LABEL THREE SCRUBBER MAINTENANCE TASKS just considered.



– Check your answers.,


1. Clean spray nozzles
3. Clean/lubricate by-pass damper
2. Clean settling tank

PERIODIC MAINTENANCE CHECKS FOR THE INCINERATOR/SCRUBBER ARE SUMMARIZED BELOW:

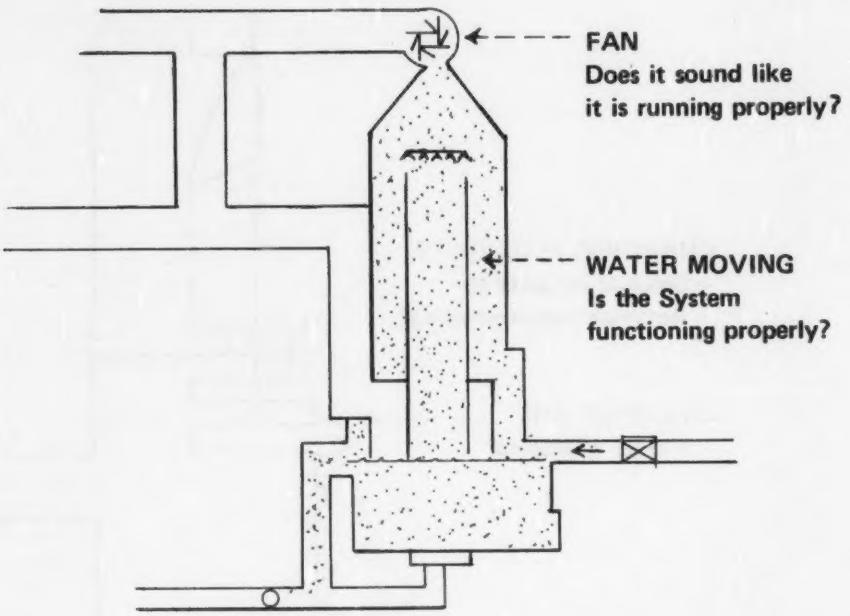
1. **Clean Ash Build-Up from Walls**
2. **Purge Charging Flue**
3. **Clean Spark Arrestor**
4. **Clean Spray Nozzles - Scrubber**
5. **Clean Settling Tank - Scrubber**
6. **Clean/Lubricate By-Pass Damper**

These maintenance tasks are listed on page 226 of the Incinerator Handbook for your future reference.

12. TROUBLESHOOTING

Even a well-run incinerator produces smoke or odors at times. If this happens, check four things which may help you solve the problem. If not, call service.

FIRST - CHECK THE SCRUBBER


FAN
Does it sound like
it is running properly?
WATER MOVING
Is the System
functioning properly?

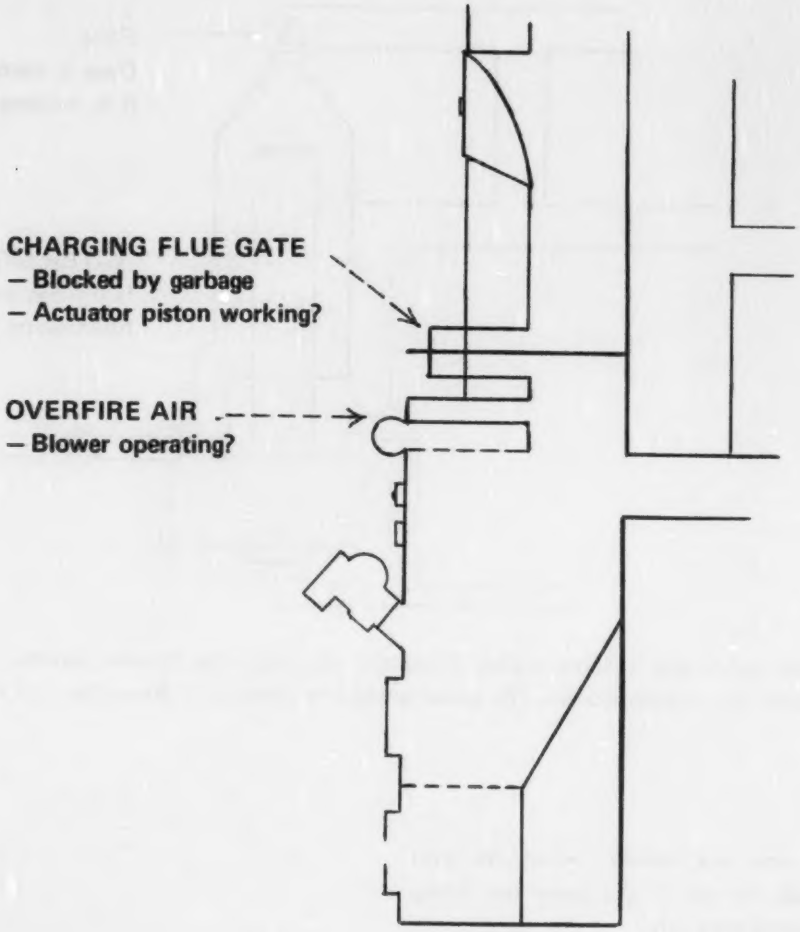
If waste gases aren't being pulled from the scrubber, the by-pass damper will automatically open and that means smoke. The gases cannot be cleaned if the water isn't vigorously cleaning them.

1. If you get smoke, what do you check to see if the gases are being cleaned properly? ____________________
2. What two things can you check in the scrubber for proper operation? ____________________

   ____

1. **Scrubber**
2. **Fan**
   Water

If the Scrubber is OK, check the OVERFIRE AIR and the CHARGING FLUE GATE.


CHARGING FLUE GATE
– Blocked by garbage
– Actuator piston working?
OVERFIRE AIR
– Blower operating?

The sound of the BLOWER generally tells you if it is operating properly. If the CHARGING FLUE GATE is stuck, you may be able to remedy the situation without calling service.

1. What could be stuck in an open or closed position which may cause smoke?

____

2. Which major air supply can cause smoke if the blower is not working properly?

____

3. What are three troubleshooting checks to make in the incinerator should you get smoke?

____

____

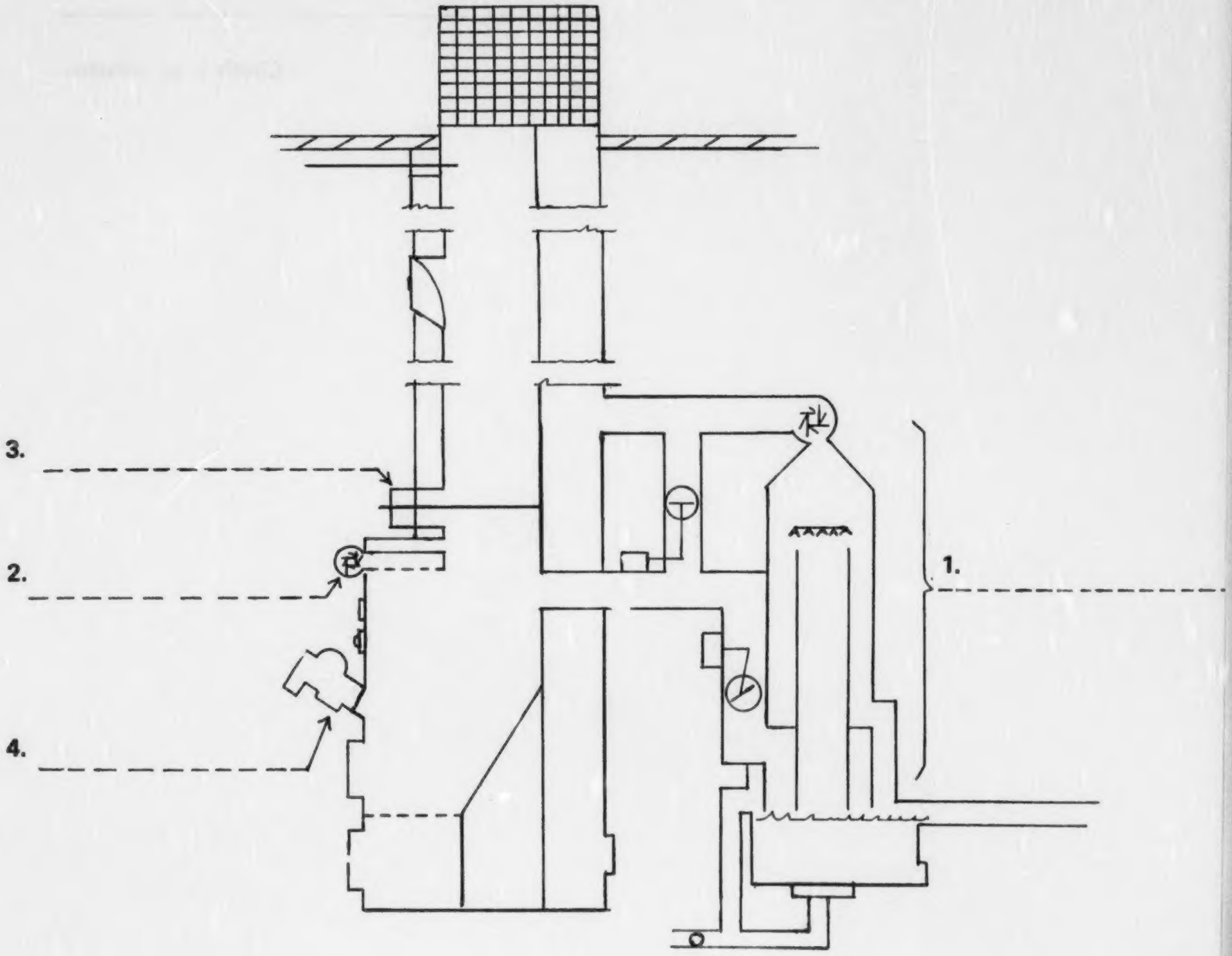
____

– Check your answers.

1. **Charging flue gate**
2. **Overfire air**
3. **Scrubber**
   Charging flue gate
   Overfire air

The last troubleshooting check before calling service – THE GAS BURNER. If the burner is not running properly, smoke will probably result. A problem here generally means calling service. You should check it out, however, as part of your information when calling service.

On the diagram below, LABEL THE FOUR TROUBLESHOOTING CHECKS to make before calling service when you get incinerator smoke.



– Check these with the list on the following page.

INCINERATOR TROUBLESHOOTING CHECKS before calling service:

1. Scrubber
2. Overfire Air (Blower)
3. Charging Flue Gate
4. Gas Burner

These are included on page 226 of the Incinerator Handbook for your future reference.

INCINERATOR SUMMARY

DAILY CLEANING TASKS

1. Grate
2. Ash Pit
3. Separation Chambers
4. Scrubber Sump
5. Scrubber Water Line Strainer

DAILY CHECKING TASKS

1. Cycling Time Clock
2. Charging Flue Gate
3. Overfire Air - Blower
4. Gas Burner
5. Scrubber - Water Circulation
6. Scrubber - Fan and Motor

PERIODIC MAINTENANCE

1. Clean Ash Build-up (all inside surfaces)
2. Purge Double Flue Incinerators - Charging Flue
3. Clean Spark Arrestor
4. Scrubber - Clean Spray Nozzles
5. Scrubber - Clean Settling Tank
6. Scrubber - Clean/Lubricate By-Pass Damper

TROUBLESHOOTING PROCEDURE

1. Scrubber
2. Overfire Air
3. Charging Flue Gate
4. Gas Burner

14. REVIEW QUESTIONS

1. Where will most of the ash collect from which it must be cleaned each day? ____________________

2. How often should the grate of the incinerator be cleaned? ____________________

3. From what two places in the scrubber should you clean residue each day? ____________________

   ____

4. What is the minimum length of time you should wait after a burn to clean the incinerator? ____________________

5. What device should be checked daily to be sure all burning ingredients are brought together properly and on time? ____________________

6. What may become jammed which would result in incomplete garbage drop or firing chamber not being closed off? ____________________

7. Which air supply is most susceptible to problems and should be checked each day? ____________________

8. Should the gas burner be checked daily or only periodically? ____________________

9. What scrubber part should be checked each day to insure proper flue gas removal? ____________________

10. The action of what basic scrubber supply should be checked daily? ____________________

11. If separation chamber floors are cleaned each day, ash build-up maintenance tasks will not be necessary. (TRUE or FALSE) ____________________

12. In a double flue incinerator, what must be done periodically to the charging flue? ____________________

13. What device at the top of the stack must be cleaned periodically? ____________________

14. What scrubber part should you clean periodically to be sure you get a good water curtain? ____________________

15. The scrubber settling tank should be cleaned DAILY, PERIODICALLY, YEARLY. (CHOOSE ONE) ____________________

16. What should be periodically done to the by-pass damper? ____________________

17. If you get smoke, what gas cleaning device should you first check? ____________________

18. What Overfire Air device should be checked in the event of smoke? ____________________

19. When troubleshooting smoke in the incinerator, should you check the Charging Flue Gate, Gas Burner, or both? ____________________

ANSWERS TO REVIEW QUESTIONS:

1. ash pit
2. every day
3. sump
   strainer
4. 1 hour
5. cycling time clock
6. flue gate
7. overfire air
8. daily
9. fan
10. water
11. False
12. purge it
13. spark arrestor
14. water nozzles
15. periodically
16. cleaned and lubricated
17. scrubber
18. blower
19. both

INCINERATOR HANDBOOK

This handbook will at first be used with Sections 5 and 6 of the training program.

After it is completed, it will be a valuable reference in keeping your incinerator in top operating condition.

CONTENTS

Parts - Definitions ____ **222**
Schematic ____ **223**
Reference Information ____ **225**
Maintenance - Troubleshooting ____ **226**

PARTS-DEFINITIONS

HOPPER DOORS - Openings through which tenants drop garbage.

CHARGING FLUE - Empty column that the garbage falls through to the furnace.

CHARGING FLUE GATE - Gate across the charging flue which collects the garbage. It is opened and closed automatically by the time clock.

OVERFIRE AIR - A fan and blower which push air through a series of nozzles in a pipe running into the furnace.

TEMPERATURE CONTROL - An automatic control which turns the burner off/on to maintain a 1400°- 1600°F burn.

CYCLING TIME CLOCK - Device set to activate various parts of the incineration system at appropriate times.

GAS BURNER - 14, Ignites the burn and increases temperature if fire cools.

HEARTH - Steep incline which causes garbage to form a pile for burning.

GRATE - Metal, louvered platform on which garbage is burned.

FIRE DOOR - Door leading to the furnace.

UNDERFIRE AIR - Manually adjustable louvers in the clean-out door which permit air to pass in and up through the grate to the burn.

CLEAN-OUT DOOR - Door to the ash pit.

AUTOMATIC BY-PASS DAMPER - Damper which opens automatically when the scrubber is off; draws flue gases past the scrubber and out the flue.

AUTOMATIC DRAFT CONTROL - Regulates furnace draft; draws flue gases into the scrubber.

SCRUBBER - Device which cleans exhaust gases by running them through a water curtain before sending them out the flue.

WATER NOZZLES - Openings through which the water is sprayed in the scrubber to form a water curtain.

SETTLING TANK - Water tank at the base of the scrubber.

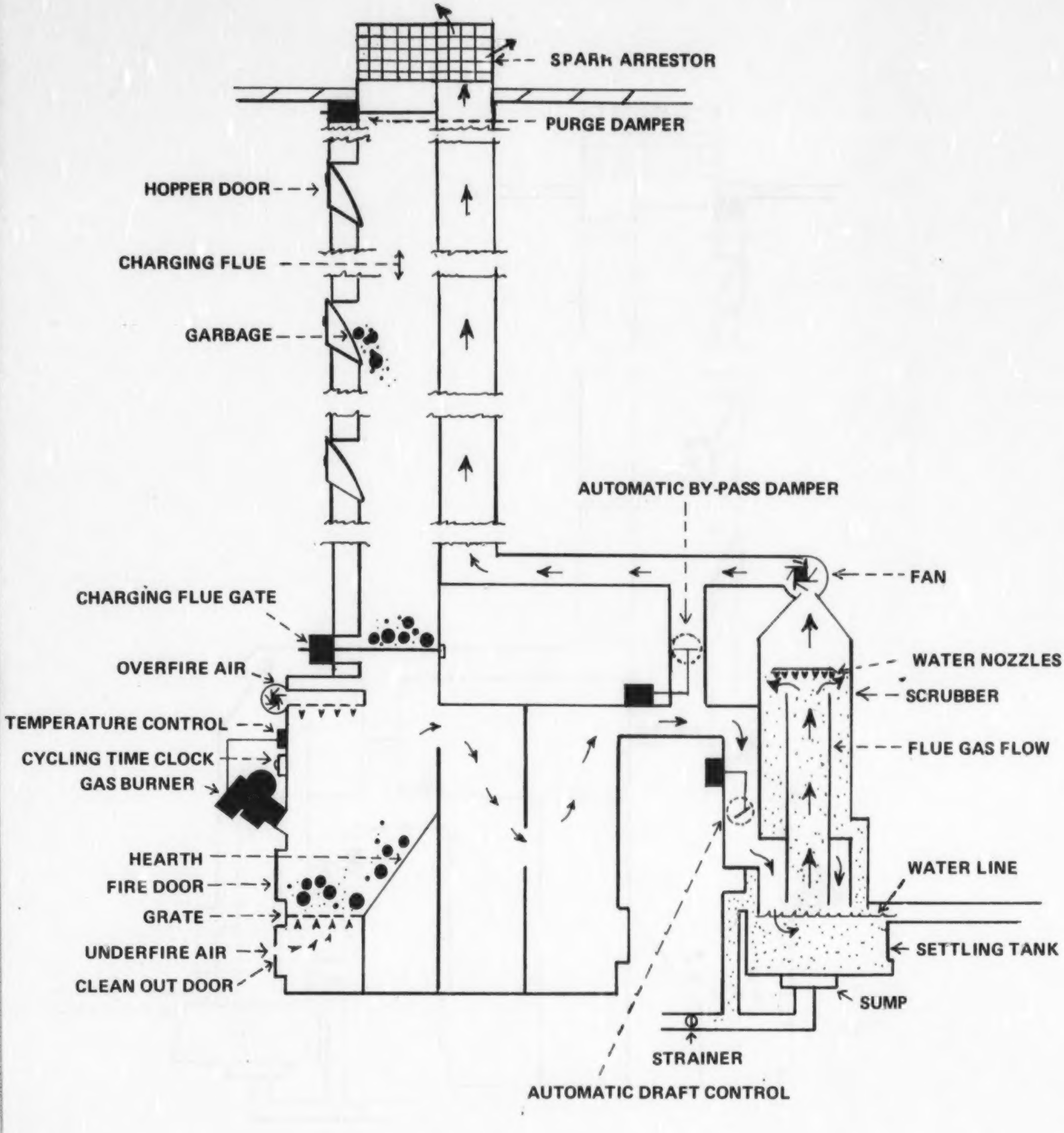
SUMP - Outlet at base of settling tank where residue taken from the gases settles.

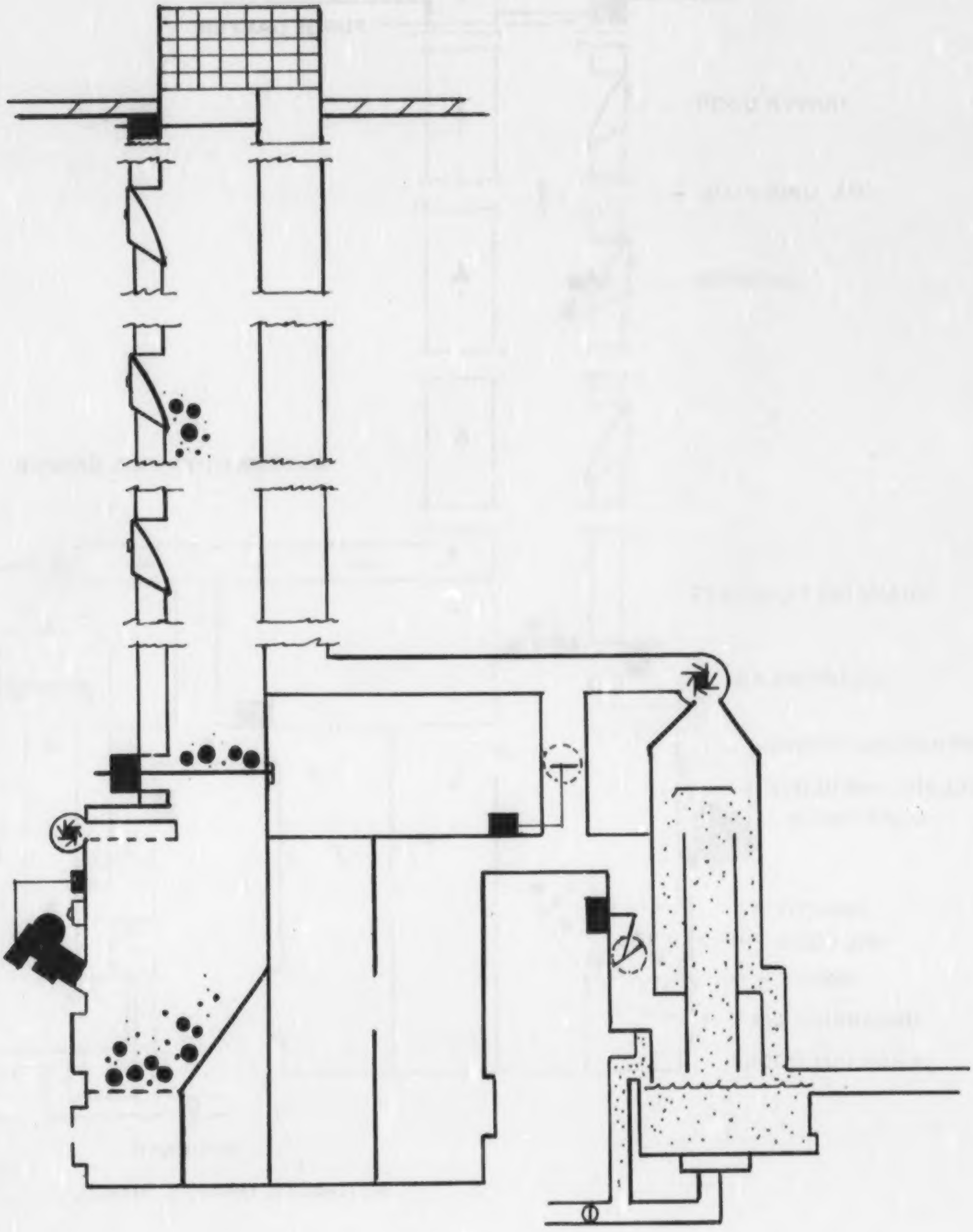
STRAINER - Device in water pipe which filters out any residue in the discharge water as it is recycled in the scrubber.

SCRUBBER FAN - Blower which takes the clean flue gases from the scrubber and directs them out the flue.

SPARK ARRESTOR - Wire screen cap over the top of chimney which will catch any large materials in the emission gases.

PURGE DAMPER - Damper at top of charging flue on double flue incinerator. Normally closed; opened to clean charging flue.


SPARK ARRESTOR
PURGE DAMPER
HOPPER DOOR
CHARGING FLUE
GARBAGE
AUTOMATIC BY-PASS DAMPER
FAN
CHARGING FLUE GATE
WATER NOZZLES
OVERFIRE AIR
SCRUBBER
TEMPERATURE CONTROL
FLUE GAS FLOW
CYCLING TIME CLOCK
GAS BURNER
HEARTH
WATER LINE
FIRE DOOR
GRATE
SETTLING TANK
UNDERFIRE AIR
CLEAN OUT DOOR
SUMP
STRAINER
AUTOMATIC DRAFT CONTROL



REFERENCE INFORMATION

Here is a place to list some basic information about your incinerator. You may have to complete parts of this page at your incinerator.

COMPLETE THE ITEMS IN THE LAST COLUMN ON THE TABLES BELOW as they apply to your system.

I. SETTINGS - You should be aware of these, even though they are seldom changed.

INSTRUMENT	SETTING
Cycling Time Clock	
Temperature Control - High & Low	

II. EQUIPMENT - Service may ask for this information if you call in a problem.

EQUIPMENT	MAKE	MODEL NUMBER
Gas Burner		
Scrubber		

III. PART SPECIFICATIONS - You may or may not replace these parts or know these sizes. If not, leave this blank.

PART	SIZE
Water Nozzles	
Water Line Strainer	

IV. SERVICE - "Who to call" in the event of trouble.

NAME	PHONE

INCINERATOR TASKS MAINTENANCE-TROUBLESHOOTING

DAILY TASKS

CLEAN	OPERATION CHECK
1. Grate	1. Cycling Time Clock
2. Ash Pit	2. Charging Flue Gate
3. Separation Chambers	3. Overfire Air - Blower
4. Scrubber Sump	4. Gas Burner
5. Scrubber Water Line Strainer	5. Scrubber - water circulation
	6. Scrubber - fan and motor

PERIODIC TASKS

MAINTENANCE CLEANING
1. Remove Ash Build-up - All inside surfaces
2. Purge Double Flue Incinerators - Charging Flue
3. Clean Spark Arrestor
4. Scrubber - Clean Spray Nozzles
5. Scrubber - Clean Settling Tank
6. Scrubber - Clean/Lubricate By-Pass Damper

TROUBLESHOOTING TASKS

CHECK IN THE EVENT OF SMOKE
1. Scrubber
2. Overfire Air
3. Changing Flue Gate
4. Gas Burner